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EDITED BY THURSTON SCOTT WELTON, M.D.

December 1944

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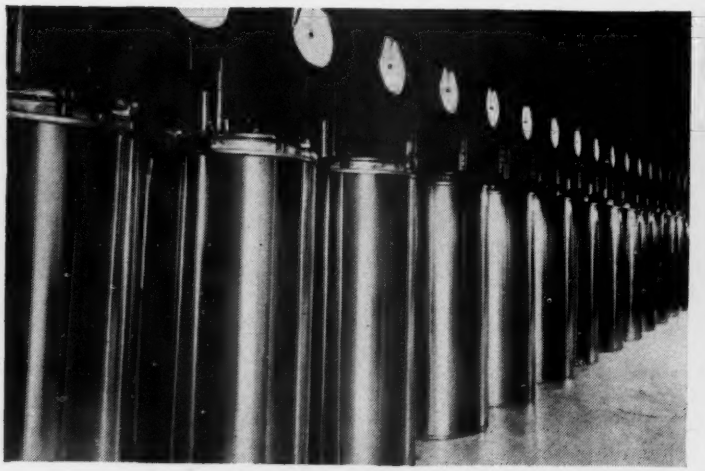

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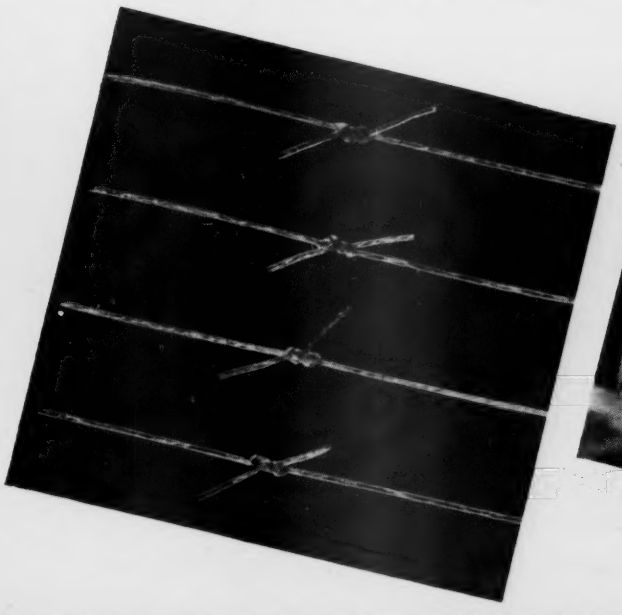

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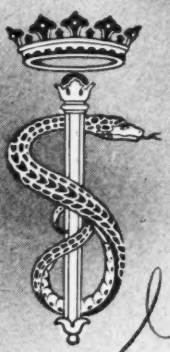

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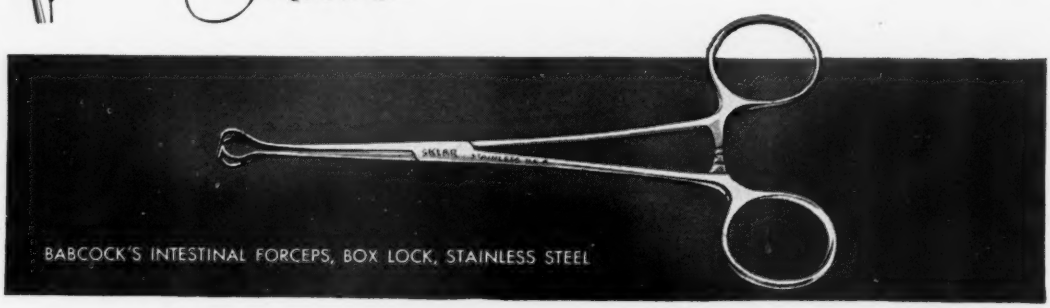

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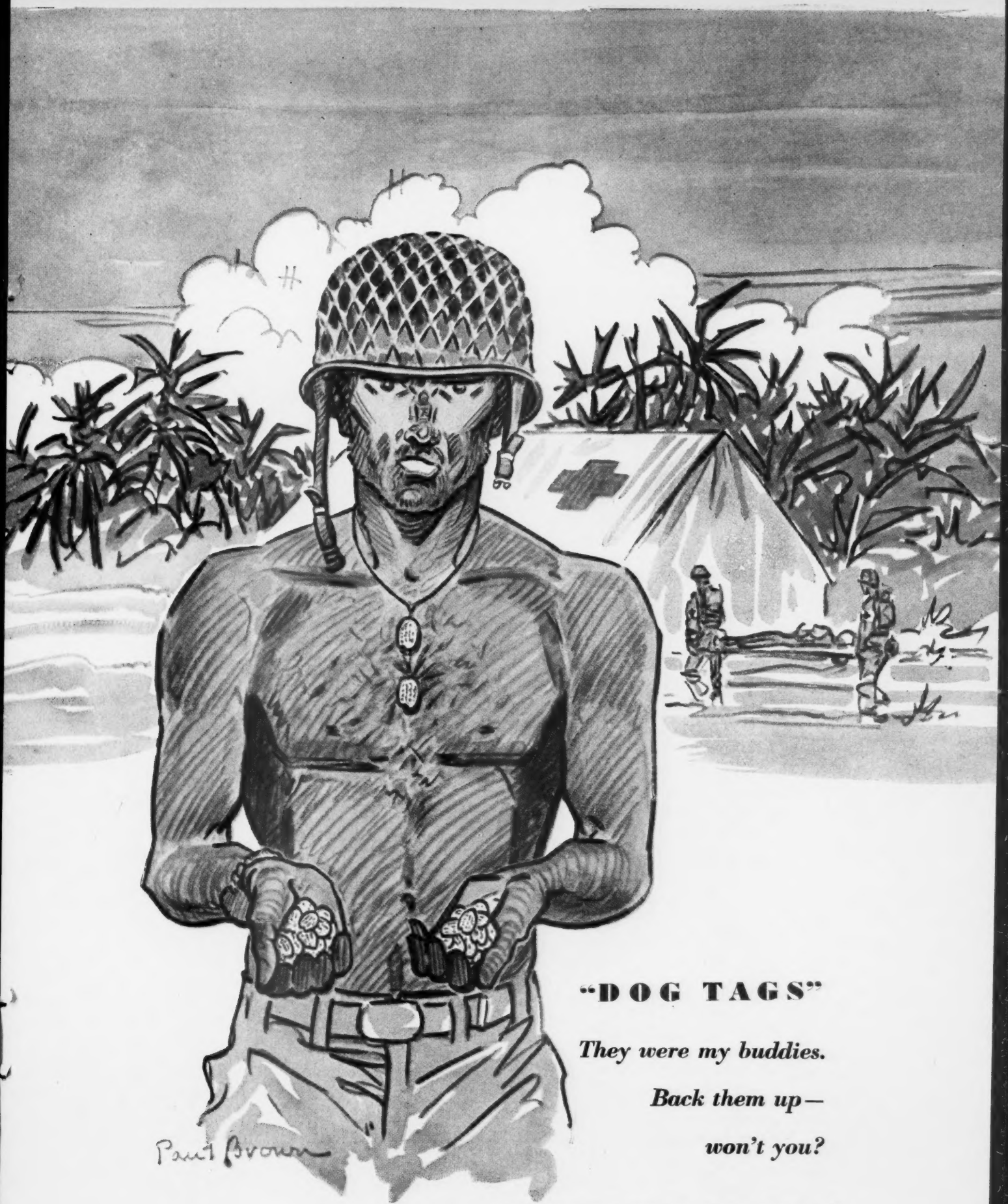

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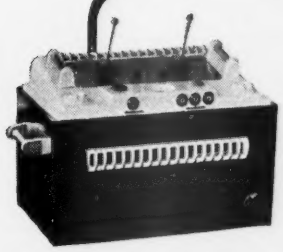

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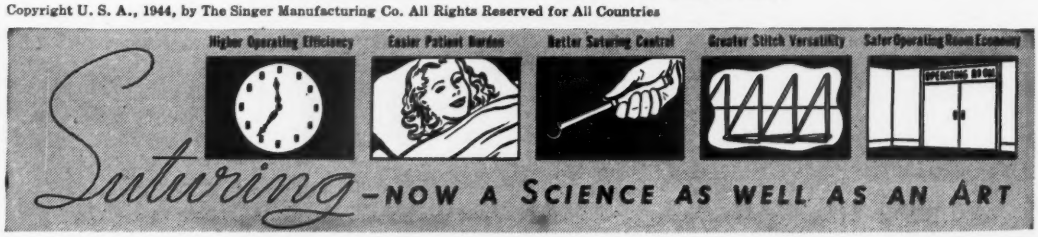

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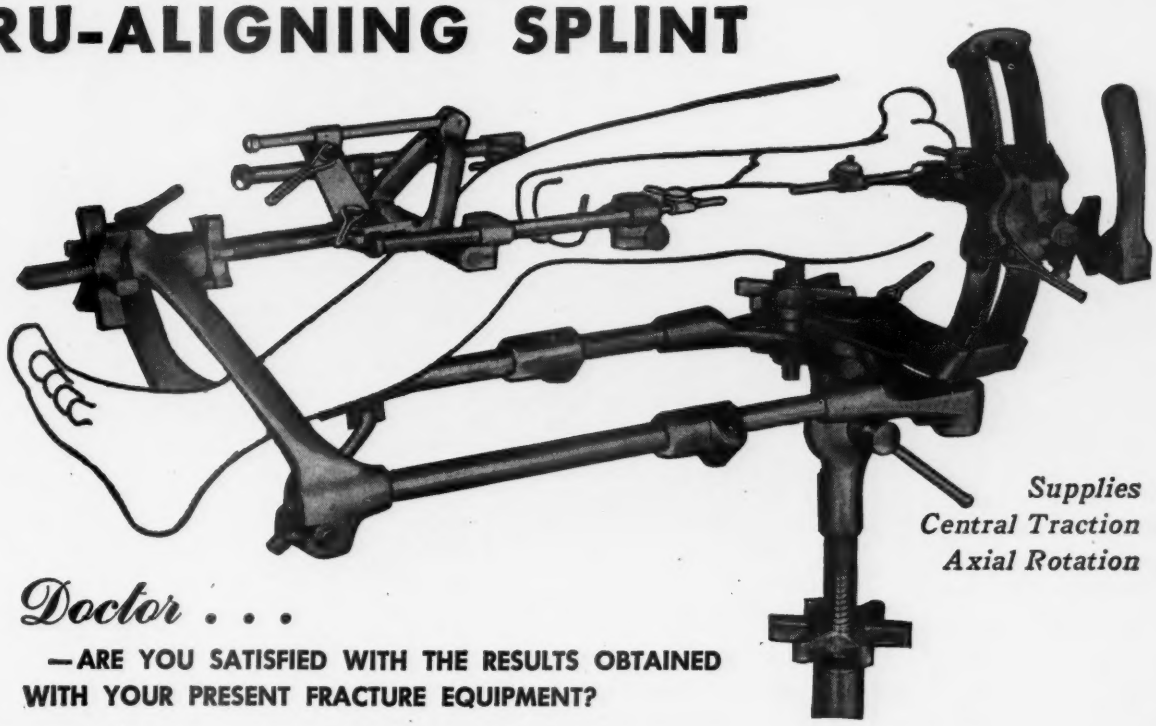

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The TRU-ALIGNING SPLINT provides complete and free rotation of the fragments even under heavy traction.

● *Does your splint permit a choice of the Roger Anderson half pins, Steinmann pins, Kirschner wires, or screws, depending on the type of treatment indicated?*

The TRU-ALIGNING SPLINT is universally adaptable. It will take half pins in various diameters, thru and thru pins, various screws, and wires of all sizes.

● *Is your reduction splint completely adjustable to the type of fracture, or can pins be used only at certain angles and on one plane only, in effect fitting the fracture to the splint rather than the splint to the fracture?*

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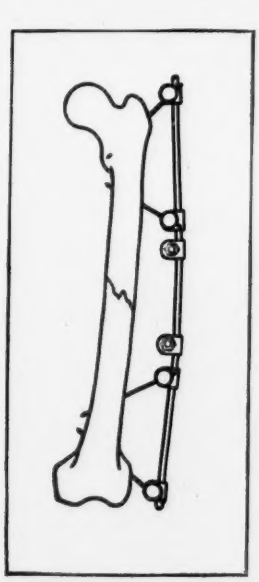
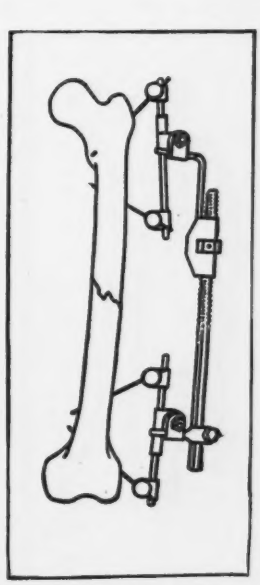


● *Is your apparatus truly a reduction splint or is it only a fixation device to hold the fragments in position after they have been manually reduced?*

The TRU-ALIGNING SPLINT is a complete reduction machine which is removed after the reduction is made, as then a light duraluminum fixation rod, as shown at the left, weighing 2 ozs., will maintain the reduction.

● *To make post-reduction adjustments is it necessary to keep a complete, elaborate and expensive fracture device on the patient?*

The TRU-ALIGNING SPLINT is *removed* after reduction. If an adjustable fixation unit is desired which will keep the ends of the bones in apposition at all times, the inexpensive adjustable fixation rod, shown at the right, may be used.



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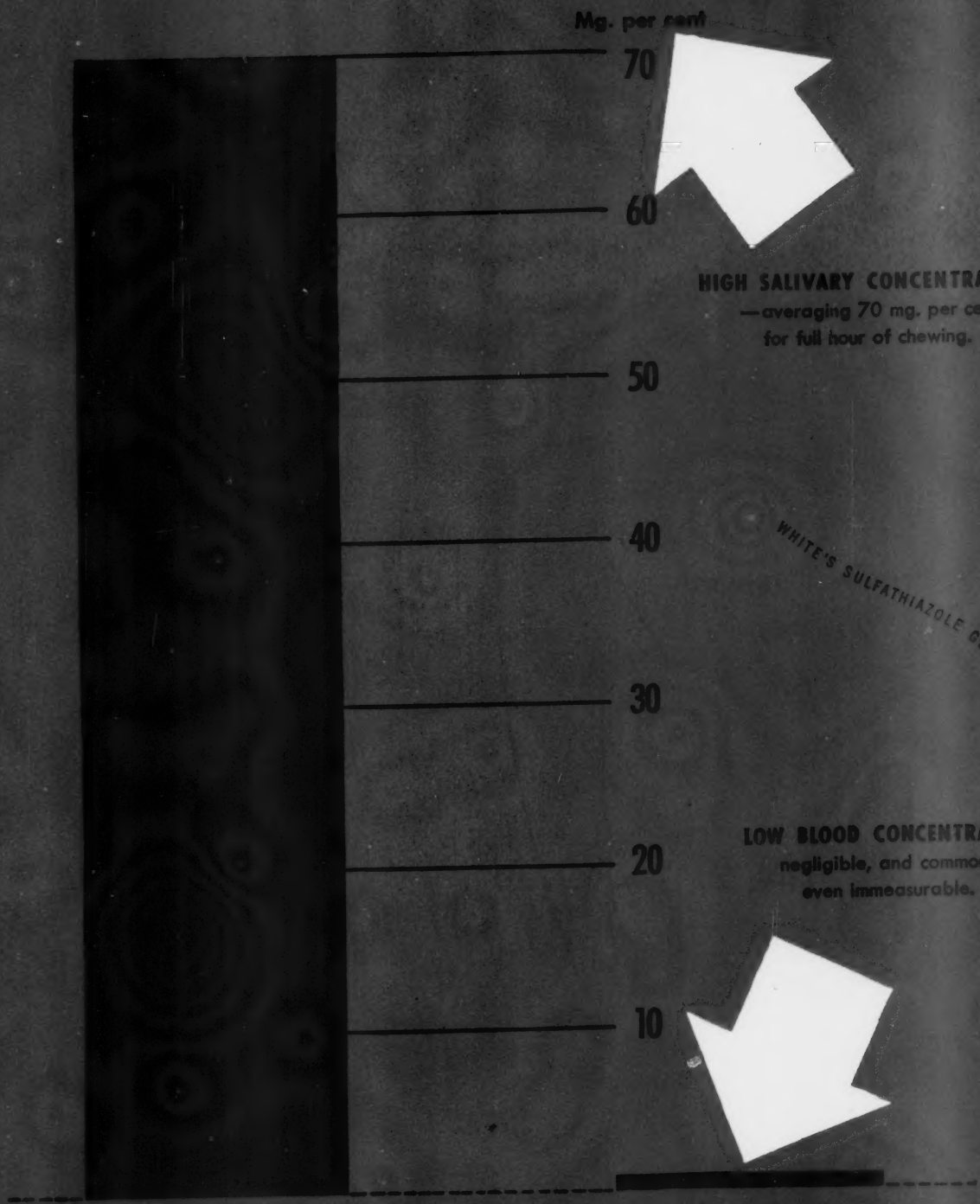
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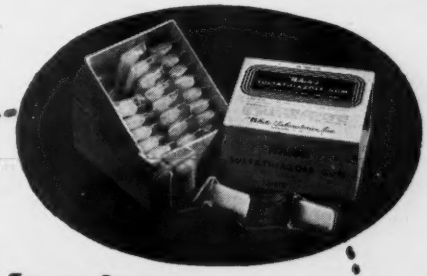

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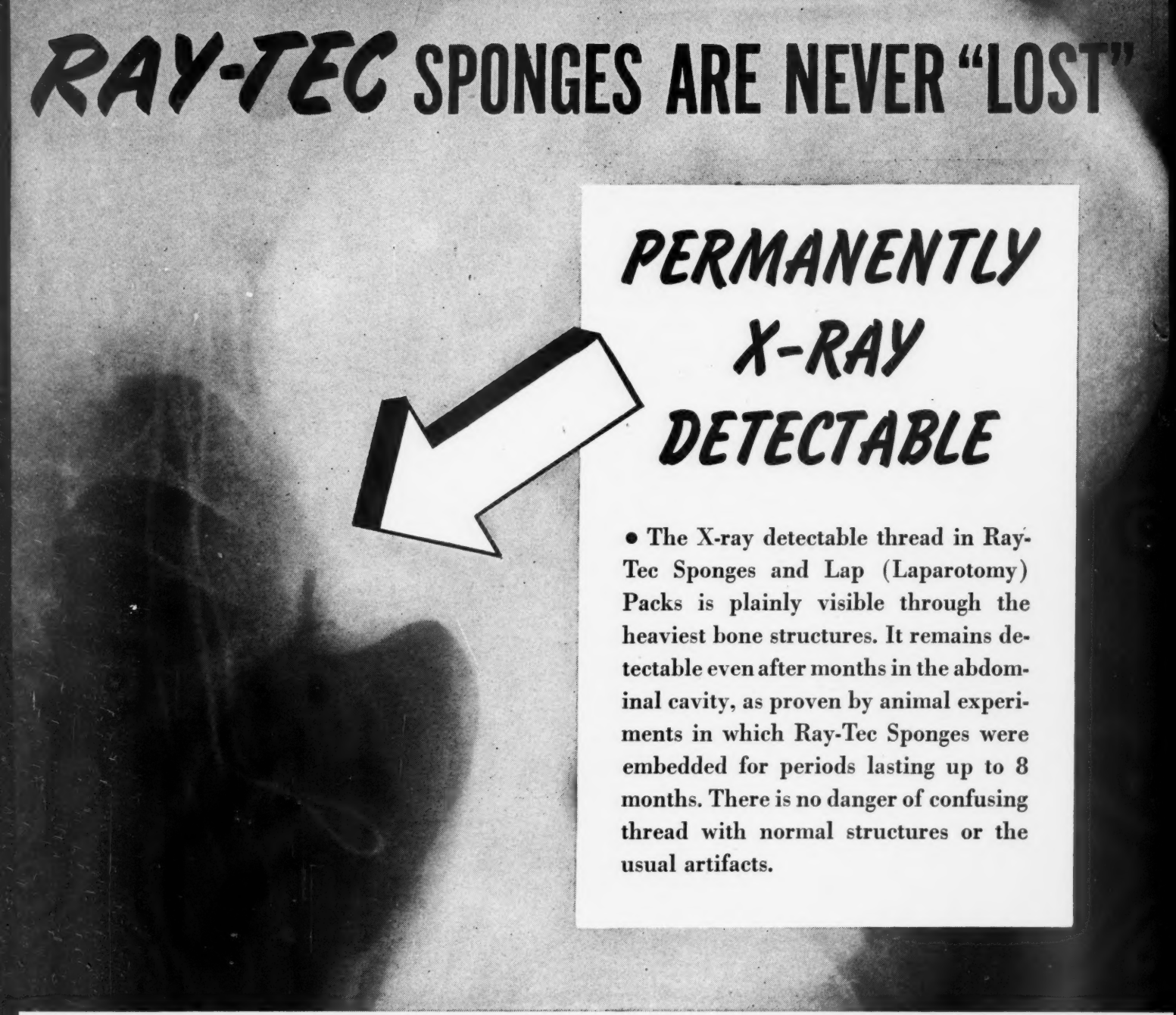

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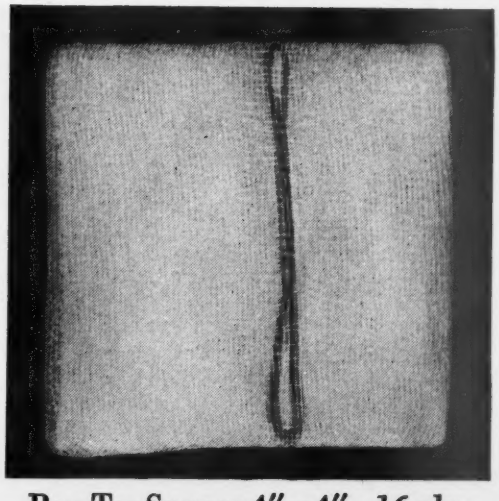

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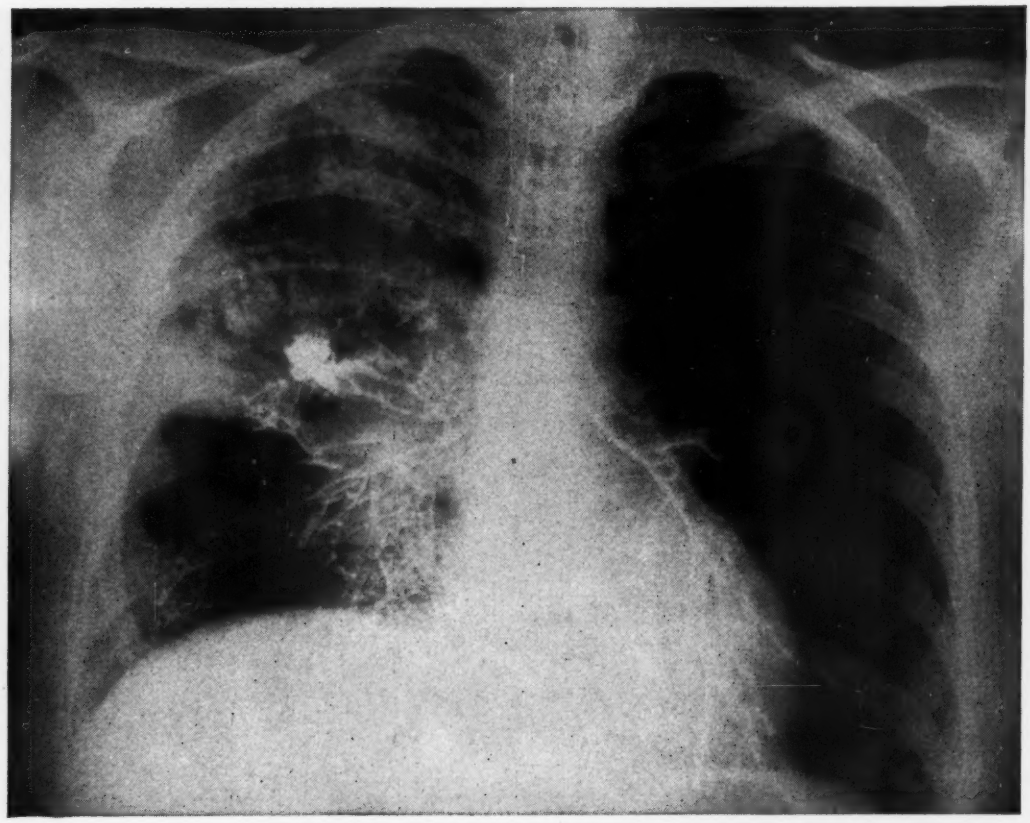

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New Eng. Jrnl. Med., 1941, 224.106

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[1]*Meyer, E., and Arnold, L., 1938, Amer. Digest. Dis., 5:418.*

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Editorial

IMPENDING DEATH DESERVES PRIORITY

THE Cadet Nurse on the tonsil cases reports that the last patient with a tonsillectomy and adenoidectomy looks blue and is having trouble breathing; the emergency ward reports a fracture and you can hear the youngster screaming; yesterday's patient with a mastoid operation has a temperature of 105°F. Impending death, pain, clinical disease! Is priority sharp, unmistakable, urgent? Are you familiar with the degree of asphyxia which presents? Do you automatically fall into the correct sequence of treatment? R. C. Adams cites the case of a boy of fifteen years with a little fibroma in his postnasal region who had five or six radon seeds implanted. Pentothal sodium was used and after the operation had been completed the boy became cyanotic and stopped breathing. Dr. Adams visualized the patient's glottis with a laryngoscope and pulled a large clot of blood out of the trachea, which had resulted in a complete respiratory obstruction and which would have caused his death if he had not had the equipment to remove it promptly.

If a patient comes to you complaining of a sore throat, you put a light in his mouth and take a look. The habit and the simple technic of looking into the throat of a patient who cannot get air is easily acquired.

An author, in December, 1933, raised the issue in an article entitled "Asphyxial Death, a Professional Disgrace." In February the Society of the Prevention of Asphyxial Death came into being. In May, the New York Academy of Medicine sponsored the first conference on asphyxia. During the summer, the problem received publicity at the Century of Progress. In 1934, a second conference was held at the Hotel Biltmore in New York City. Leaders in all fields in which asphyxia is encountered presented papers. In less than a year the New York State, the New York County and the A.M.A. approved the aims and purposes of the new Society to prevent asphyxial death. In 1935, an extensive exhibit on asphyxia was held at Atlantic City in conjunction with the A. M. A. In 1936, 1,700 hospital superintendents were invited to act on a nation wide committee to consider asphyxia from the viewpoint of hospital administration. Three hundred thirty-five accepted, twenty of whom directed hospitals of more than 2,000 beds; forty-two states were represented. In the same year the A. M. A. appointed a committee on asphyxia. The committee's report, which was approved by the house of delegates of the A. M. A., appears in the May 1st issue of the Journal for 1937. In 1938, a communication regarding the

treatment of asphyxia neonatorum was addressed to the professor of obstetrics of every medical school of this country and Canada; sixty-three medical schools responded. This response, a new classification for the stages of asphyxia and an acceptable routine treatment were outlined in the Maine Medical Journal, January 1940.

In June, 1939, Surgeon General McIntire opened the S. P. A. D. Department of Pneumatology at the New York World's Fair. In 1940, $6,000 worth of resuscitation equipment was donated to the British war relief by the S. P. A. D. and shipped safely to England. In December, 1941, the special committee on infant mortality of the New York County Medical Society contacted all private hospitals in New York City with the suggestion that arrangements be made with the S. P. A. D. to provide instruction in resuscitation.

Eleven leading hospitals expressed their interest. When the question of an honorarium for instruction was raised, all interest died out. The proposal for instruction was placed before the Children's Bureau, Washington D. C., 1942, and subsequently to the director of Maternal and Child Welfare of every state in the union. The directors of fifteen states responded. But the necessary financing to carry out instruction could not be secured.

In order that the efforts noted above may not perish forever, the writer has included them in a new book entitled the "Art of Resuscitation."

What, it may be asked, has been the practical result of all these conferences, resolutions, approvals, studies and recommendations? It would seem not even a mouse, for today the *average practitioner* is not conversant with asphyxial mortality, is not prepared to render relief in cases of advanced asphyxia, and is not familiar with the stages of asphyxia. The *trained nurse* is not asphyxia conscious and is not trained in methods suited to the care of the unconscious patient. The *average hospital*, municipal as well as private, is not informed, prepared or organized to deal with asphyxial accidents in accordance with accepted up-to-date methods. The *medical schools* do not integrate the predisposing causes of asphyxiation; instruction, when offered, is subordinated to instruction in anesthesia which is a restricted intramural field.

Such subordination renders relief in accidents occurring outside the operating room illogical, impractical and impotent. Anyone who wishes to take the trouble to confirm the foregoing may do so by making the following inquiries directed to half a dozen practitioners, nurses, hospitals, medical schools and First Aid Squads:

General Practitioner:

Do you believe asphyxiation to be a serious medical problem?

How do you deal with such cases?

What treatment do you advocate for the various stages of asphyxia?

Nurses:

What are you taught relative to the care of patients who have difficulty in breathing?

What treatment is advocated for the various stages of asphyxia?

Do you believe asphyxia or suffocation to be an important problem?

Who lectures to you on asphyxia?

Hospitals:

Who on your staff is called to care for the following emergencies? Carbon monoxide poisoning, a severe case of poliomyelitis, an unconscious patient who is having difficulty in breathing, an electrocuted patient, a victim of chemical gas poisoning, a recently submerged patient, a case of asphyxia or suffocation?

What treatment do you advocate for the various stages of asphyxia in the newborn?

What routine is practiced in patients who return from the operating room following a nose and throat or other operation?

Medical Schools:

In what department can I secure information regarding the following subjects: Carbon monoxide poisoning, drowning,

electrocution, the asphyxiation of poliomyelitis, suffocation, respiratory obstruction from foreign bodies, drug poisoning leading to unconsciousness, subjects overcome in burning buildings, severe heart failure?

Is the subject of resuscitation taught? By whom?

Who is in charge of asphyxia in the newborn? How are the various stages of this condition met?

First Aid Squads, Fire and Police:

Who instructs your men?

Where does the squad secure medical assistance?

What becomes of your asphyxiated patients after the accident?

What stages or degrees of asphyxia do your men recognize?

Impending death from asphyxia would certainly seem to deserve priority over all other considerations; because if we lose life, pain, disability, liberty and the pursuit of happiness are not particularly important.

While the foregoing is in no sense intended as an indictment of the medical and nursing profession, since there are several reasonable explanations for the conditions outlined, nevertheless under the present pressure for medical care those who may claim priority receive first attention. Upon this basis alone, asphyxial death is without doubt deserving of respectful prompt and skilful attention.

From what has been said, it is fair to conclude that the prevention and the treatment of asphyxia will turn upon the public demand that it be rescued *now, today*, by the following measures which must be freed from competition with lesser evils, as the control of pain and the treatment of disease: (1) Widespread and general knowledge concerning the nature of the problem and its mortality; (2) professional interest aroused to the end that physicians be prepared instantly to meet such accidents along modern lines of treatment; (3) the relegation of resuscitation apparatus to its normal position, as a means instead of an end; and (4) the public insistence that asphyxial death is a grave medical problem of more immediate importance than wounds, hemorrhage, fractures, or constitutional disease.

Priority will be given the prevention of asphyxial death if and when an unmistakable demand for it develops. It will come when the public insists upon prompt, informed and expert medical attention for acute asphyxial accidents.

Paluel J. Flagg, M.D.

Original Articles

GAS GANGRENE IN AMPHIBIOUS WARFARE IN THE PACIFIC AREA

LIEUT. HARRY B. NEEL
MEDICAL CORPS, UNITED STATES NAVAL RESERVE

AND

LIEUT. JAMES P. COLE
MEDICAL CORPS, UNITED STATES NAVAL RESERVE

GAS gangrene is one of the most serious complications of wounds received in both war and civil life. Our present knowledge of this dreaded infectious process was largely derived from the experiences of the first World War, during which gas gangrene was of common occurrence and interest in it was accelerated. In years of peace anaerobic infections are not numerous and many physicians and surgeons may not be called upon to treat gas gangrene during their entire practicing careers.

The present war has given new impetus to the study of gas gangrene as a complication of war wounds. As experience is acquired by those who care for fresh casualties, and as knowledge is gained and disseminated, it is highly probable that the incidence of this complication can be reduced and the mortality decreased. It seems desirable to record observations which might be of assistance in the prevention, early diagnosis and treatment of gas gangrene and it is for that reason that the seven cases seen in this hospital are reported.

Although Maisonneuve is generally credited with the first description of gas gangrene, in 1853, there has recently been unearthed evidence which indicates that this distinction should go to Fabricius Hildanus. In August, 1607, he wrote a letter to Gregorious Horstius in which he described accurately and concisely a case of gas gangrene in a farmer who had sustained a compound fracture of the leg when he was run over by a wagon wheel. The clinical course of the infection was carefully observed and recorded. The severe pain, the swelling, discoloration of the skin, crepitus, the formation of blebs, the ascent of the infection up the extremity to the scrotum, the rapid pulse, and finally death while still rational, constitute the picture with which we are familiar today.

Kellett, to whom we are indebted for the correction of this historical inaccuracy, stated that gas gangrene was probably rare before the middle of the nineteenth century. Until the advent of antisepsis the common form was that known as "hospital gangrene" which was complicating approximately 80 per cent of all wounds in some continental hospitals.

In 1892 Welch and Nuttall discovered and isolated the anaerobe now known as Clostridium Welchii and which is present in the great majority of cases of gas gangrene. This organism, Clostridium septique and Clostridium oedematiens are the most important pathogenic anaerobes and are classified as saccharolytic anaerobes because of their avidity for carbohydrates. They are said to produce lactic and butyric acids, upon which the odor of gas gangrene is dependent, and they produce large amounts of gas. These organisms are gram-positive, spore forming bacilli but each has distinguishing morphological and cultural characteristics.

In 1916, a toxin similar to that of diphtheria and tetanus and with pronounced

hemolytic properties was isolated from the Clostridium Welchii and, later, an antitoxin was prepared which gave complete protection against pure cultures of Clostridium Welchii in laboratory animals.

According to Zinsser and Bayne-Jones, Clostridium Welchii was present in 80 per cent of all wounds bacteriologically examined during the first World War but only 10 per cent developed gas gangrene. In 72 to 80 per cent of the cases of gas gangrene Clostridium Welchii was found. In the Middle East, during this war, McLennan found that 20 to 30 per cent of all war wounds contained sporing anaerobes and in cultures from 146 wounds with gas gangrene the Clostridium Welchii was found most frequently. In all other theaters from which reports have been made Clostridium Welchii has been the predominating anaerobe. Clostridium oedematiens and Clostridium septique have been found rarely.

Firor has pointed out that no cases of gas gangrene have been reported in which there were only anaerobic bacilli. In over one-half of the cases of gas gangrene, aerobic pathogenic cocci and bacilli have been found and it is probable that symbiotic relationships have been established. It is said that streptococci stimulate the growth of Clostridium Welchii. There was a mixed infection in each of the cases seen in this hospital but in all cases Clostridium Welchii was present.

Since Clostridium Welchii normally inhabits the gastrointestinal tracts of man and animals, and because the spore forms may survive for years in soil, it is logical that gas bacillus infections have been associated with wounds contaminated by soil. The infection also occurs in other wounds, however, such as in stumps following amputations for diabetic and arteriosclerotic gangrene. In one case in this small series the patient was wounded aboard a war ship and his wound was contaminated only from his skin and clothes.

In the Middle East the incidence of gas gangrene in war wounds was found by McLennan to be 0.32 per cent. Collier stated that the infection occurred with "tragic frequency" during the early period of the war in Spain. The incidence in the Dieppe raid is given as 3 per cent and in the Southwest Pacific as between 1.5 and 2 per cent. In 984 consecutive fresh battle casualties treated in this hospital ship, in practically all of which the wounds were incurred in amphibious operations, there were seven cases of gas gangrene, an incidence of 0.71 per cent.

There is a predilection for the large muscle groups since the infection is primarily an infection of muscle. McLennan said that the lower limb was affected in 75 per cent of cases seen in the Middle East. Of the cases seen in this hospital the upper extremity was affected in two (28.5 per cent) cases while in the remainder (71.5 per cent) the lower extremity was the site of the infection.

Some writers have described a localized anaerobic cellulitis as a distinct type of gas gangrene and it is said that in some infections the process has been limited to one muscle or to a group of muscles. Six of the infections observed in this hospital ship were of the fulminating variety, muscles and adjacent structures being involved, and rapid extension was a predominating characteristic.

According to Firor, depending on the virulence of the organism and the amount of devitalized tissue, the incubation period varies from one to four days. In one case seen in this hospital ship it was five days after the injury before signs and symptoms of gas gangrene appeared but the average time elapsed between injury and appearance of signs and symptoms was 2.35 days. Without exception the wounds in the patients with gas gangrene were large, deep, irregular and involved muscle and fascia. In five of the seven cases fractures had been sustained.

PATHOLOGY

In traumatized and devitalized muscle whose blood supply has been diminished

or abolished, the pathogenic anaerobes find conditions essential for their growth. In the initial stages of the disease the muscle is dull and opaque. It fails to respond to stimuli, does not bleed when cut and appears lifeless in every respect. Bubbles of gas may be seen to escape when the muscle is cut and on palpation crepitus may be elicited. As gas and toxin are produced by the multiplying organisms, they infiltrate the individual muscles and the groups of muscles, both distal and proximal to the wound, separating the muscle fibers from the interstitial tissue. The swelling and tenseness incident to the gas and exudate cause further ischemia, small blood vessels are damaged and ruptured, and the color of the tissues progresses from dark red to black.

On microscopic examination the muscle fibers are found to be separated from the surrounding interstitial tissue by a clear space. The fibers lose their normal striations, later become coagulated and stain a uniform pink. In some areas the nuclei of the sarcolemma may be present and the normal architecture persists. The sarcolemma later disappears and the coagulated muscle disintegrates. The bacilli are demonstrated in the interstitial spaces and, at a later stage, in the degenerating muscle. Perivascular polymorphonuclear infiltration and thrombosis of the blood vessels are observed.

CLINICAL MANIFESTATIONS

Pain, or accentuation of the pain already present, was one of the earliest symptoms in this group of cases. The elevation of the temperature varied considerably. It was rarely alarming and was not consistent with the severity of the infection. In nearly all cases the pulse was hurried and was easily compressible. The patient usually remained unaware of the seriousness of his condition. The pallor and the general appearance of marked toxicity were striking and alarming.

The affected part was swollen, tense and discolored, and most of the wounds contained necrotic tissue. The discharge from the wound was profuse, was colored by blood and invariably had a foul odor, one difficult to describe but characteristic of gas gangrene. Crepitus was nearly always elicited in the surrounding areas. In five of seven cases the extremity distal to the wound was cool and blue.

The progressive decrease in the number of erythrocytes in the circulating blood was impressive. The erythrocyte count in one patient became as low as 1,900,000 per cu. mm. of blood and in one case the hemoglobin estimation was 5.5 Gm. per 100 cc. The leucocyte count in the cases reported varied between 10,400 and 22,100 per cu. mm. of blood and was not considered to be of diagnostic value.

Savill has said that gas gangrene is often diagnosed too late and suggests that *x*-ray examination may often result in a more prompt diagnosis. Two types of gas infiltration are demonstrable. In one type the soft tissues are musty or hazy, and full of gas bubbles, while in the second type there are streaks, as of gas between the muscle fibers. Bubbles of air which are carried into the tissues by missiles must not be interpreted as gas produced by gas forming anaerobes. In one case observed in this hospital ship the *x*-ray film made on admission revealed the presence of gas throughout the leg. The tissue planes were separated by gas and muscle fibers were demonstrated by the infiltration of gas between them. (Fig. 1.)

The mortality of anaerobic infections is notoriously high. From the Middle East McLennan reported a mortality of 50 per cent. In the seven cases observed in this hospital ship two patients died, a mortality of 28.5 per cent. One of these patients was moribund on admission, the infectious process had already spread to his thorax from the stump of a traumatic amputation of the arm, and the patient died within a few hours after being admitted.

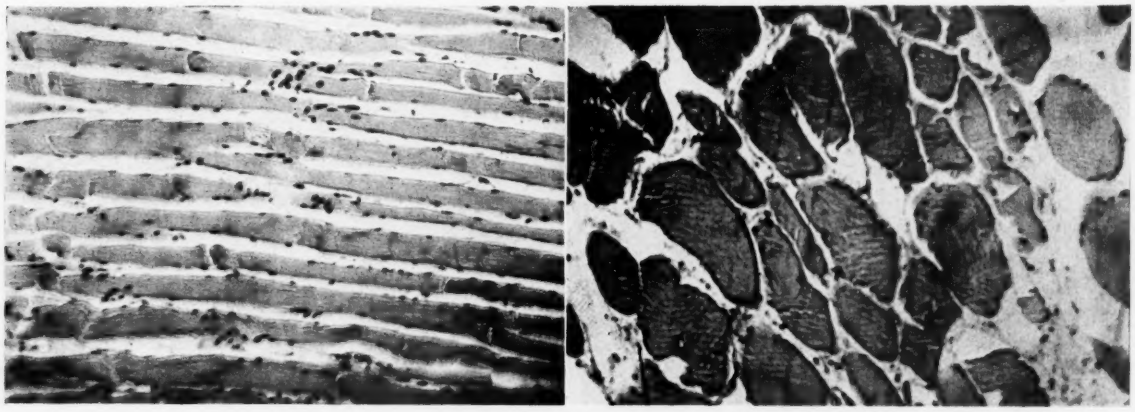
TREATMENT

The most effective prophylactic measure for gas gangrene is early and complete excision of devitalized tissue and thorough cleansing of the wound, into which vaseline gauze is then lightly placed, and the extremity immobilized. Polyvalent gas gangrene antitoxin should be administered to those patients who have large, dirty wounds which involve muscle. The exigencies of modern war prevent the immediate and ideal treatment of all wounds. Therefore, it is unlikely that gas gangrene can be entirely eliminated as a complication of war wounds.

The treatment of established gas gangrene is primarily surgical. It should be emphasized that without adequate surgery all other efforts are doomed to failure. In the milder or localized cases all the necrotic and affected tissue must be completely excised so that only viable, well oxygenated tissue remains. Counter incisions help to relieve tension and are of some value. The wound should be left open and tissue planes drained adequately.

FIG. 1. Photograph of *x*-ray plate of leg in which there was advanced gas gangrene. The tissue planes and the muscle fibers are well outlined by infiltration of gas.

Conservative surgical measures, such as the one described above, were applicable in only one case of the seven seen in this hospital ship. In the remaining cases amputation was necessary and was performed through healthy tissue well above the affected area. The stump should be left open with vaseline gauze placed in it and with flaps adequate for secondary closure. It is necessary to observe the stump for evidence of extension of the infection.



A B

FIG. 2. Low power microphotographs of longitudinal and cross sections of muscle from a case of gas gangrene. The fibers are separated by gas, the interstitial tissue is still intact and the nuclei of the sarcolemma are distinct.

Blood transfusions are given liberally. Without multiple transfusions it is doubtful if many of the patients in the fulminating cases would survive. Usually the patient is anemic because of hemorrhage and the hemolysin of the infection further decreases the number of erythrocytes and the hemoglobin in his circulating blood. Whole blood should be administered in adequate quantities regardless of the actual number of transfusions. In the seven patients treated in this hospital ship the greatest amount of blood given to one patient was 3,500 cc., the smallest amount given to one patient was 1,000 cc., while the average amount per patient was 1,900 cc. Plasma was useful in the treatment of shock but it is not an adequate substitute for whole blood in the treatment of gas gangrene.

The administration of a sulfonamide, either orally or intravenously, is recommended by most surgeons. Sulfadiazine and sulfathiazole are the drugs of choice. In the U.S. Army an initial dose of 4 Gm. is prescribed and a maintenance dose of 1 Gm. is given every four hours. It is desirable to alkalinize the urine and to provide an adequate fluid intake in order to maintain kidney function.

The value of sulfonamides in the therapy of gas gangrene is equivocal, however. In experimental animals Caldwell found that sulfonilamide crystals implanted in wounds infected with Clostridium Welchii seldom controlled or prevented gas gangrene. Page stated that the sulfonamides are on trial and in McLennan's experience sulfonilamide therapy did not appear to be useful in anaerobic cellulitis.

Although serum is not always effective in the treatment of gas gangrene, the polyvalent antitoxin should be administered intramuscularly or intravenously in all cases. It has been recommended that three ampules of the trivalent antitoxin be given every hour until signs of improvement appear. The bivalent antitoxin (Clostridium Welchii and Vibrion septique) was available in this hospital ship and 20,000 units were given intramuscularly every three hours.

The average dose of gas gangrene antitoxin in McLennan's series of successfully treated patients was between 40,000

and 50,000 units. One patient in this hospital received 300,000 units. Following adequate surgical treatment, on theoretical grounds, it should be necessary to administer only sufficient antitoxin to neutralize the toxin already produced.

Penicillin was used in the treatment of six patients with gas gangrene in this hospital ship. It is not possible to draw any conclusions as to its efficacy because it was only one of several adjuncts to surgery. In other hands results have not been encouraging, toxemia has not been affected and it was thought that fulminating cases could not be saved by penicillin alone.

Many claims have been made for *x*-ray therapy in the treatment of gas gangrene. A statement of the National Research Council is to the effect that the effectiveness of *x*-ray in the treatment of gas gangrene has not been established and the use of *x*-ray therapy in gas gangrene is still experimental.

In Meleney's hands the instillation of a creamy suspension of zinc peroxide into the wound, following careful excision, has given good results both as a prophylactic measure and in the treatment of established gas gangrene. The efficacy of zinc peroxide as a prohylaxis was confirmed experimentally by Caldwell.

CASE REPORTS

Case I. A first lieutenant, age twenty-four years, sustained a compound fracture of the right humerus on February 22, 1944. There was a deep, irregular wound which measured approximately 20 by 10 cm. The initial blood count was erythrocytes 2,150,000 per cu. mm., leucocytes 10,400 per cu. mm., and hemaglobin 6 Gm. Following cleansing and débridement of the wound, a hanging cast was applied.

On February 27th the patient complained of pain in the arm. The fingers were swollen, bluish in color and motion was limited. A foul odor was present and crepitus was demonstrated in the lower arm. The temperature had fluctuated between 100°F. and 102.2°F. The pulse rate had shown a tendency to rise.

Under pentothal sodium anesthesia the arm was amputated a few inches distal to the shoulder joint. The temperature rose to 105°F., the patient became delirious, the pulse rate was 160 per minute and recovery seemed

Fig. 3. High power microphotograph of muscle from a case of gas gangrene. The fibers, the striations of some of which have disappeared, are separated by gas. There are myriads of bacilli between the fibers.

improbable. On the following day there was a marked improvement, however, and the patient made a satisfactory recovery. Direct smears and cultures from the wound yielded organisms which were morphologically and culturally identified as Clostridium Welchii.

Comment. In this case the incubation period of five days was much longer than the average. The elevation of temperature was not sufficient to cause one to suspect the presence of a serious infection. In retrospect, the persistent rise in pulse rate was significant. Early diagnosis of gas gangrene is dependent upon examination of the wound and surrounding tissues which was prevented in this case by the presence of a cast. Suspicion of gas gangrene was aroused when the patient complained of pain in his hand and lower arm. This was produced by swelling. Despite malignant and extensive spreading gas gangrene of the upper arm, this patient's recovery can probably be attributed to two factors: (1) high amputation of the arm above the involved area, and (2) the administration of a large quantity of blood.

Case II. A private, age twenty-five years, sustained a large, irregular, deep, dirty wound of the right leg which measured approximately 15 cm. in diameter, and a badly comminuted

fracture of the right tibia on February 21, 1944. The wound was cleaned, débrided, left open and a cast applied. Sulfathiazole therapy was instituted by mouth.

On February 23rd the patient complained of severe pain in his leg. The temperature was 104°F. and the pulse rate 118 per minute. A foul odor, and swelling and discoloration of the toes were present. Amputation was performed through the mid-thigh under spiral procaine anesthesia. Smears and cultures from the wound revealed the presence of gram-positive bacilli which were culturally and morphologically identified as Clostridium Welchii. Smears from the stump, taken at the time of operation, showed a few scattered gram-positive cocci but culture failed to yield the gas bacillus.

In spite of the administration of multiple transfusions, gas gangrene antitoxin and penicillin, the patient's condition grew steadily worse and he expired on February 26th. The typical subcutaneous gaseous emphysema had extended to the buttock, the flank and lumbar region, and the right lower abdominal wall. Microscopic sections from the stump musculature revealed the characteristic picture of gas gangrene.

Comment. In this case also an earlier diagnosis was prevented by the presence of a cast. Because of extension of the infection beyond surgical access, the outcome was unfavorable in spite of very high amputation and the use of sulfathiazole, penicillin and gas gangrene antitoxin.

Case III. A private, age twenty years, was wounded in the right thigh and left arm on February 2, 1944. When the patient was admitted to this hospital on February 3rd he was pale, acutely ill, quiet, responsive. His temperature was 102°F., the pulse rate was 120 per minute and the blood pressure, in millimeters of mercury, was 116 systolic and 90 diastolic. The right upper thigh was swollen, tense, and bluish in color. On the posterolateral aspect of the thigh there was a large wound about 15 cm. in diameter. The skin edges were necrotic, the wound was dirty, fascia and muscle were exposed, there was moderate seropurulent drainage and the odor was offensive. Fine crepitus was elicited. The leucocytes numbered 21,200 per cu. mm. of blood and the hemoglobin estimation was 7.5 Gm. There were no fractures.

Transfusions amounting to 1,000 cc. of whole blood were administered, 140,000 units of gas gangrene antitoxin were given in divided doses, and sulfathiazole therapy was started soon after admission and continued. Under pentothal sodium anesthesia the foreign bodies were removed, necrotic tissue excised and counter incisions were made anterior to the wound which was left open. Smears and cultures from the wound revealed the presence of gram-positive bacilli identified morphologically and culturally as Clostridium Welchii.

The patient improved rapidly and was transferred in good condition on February 10th.

Comment. Due to the fact that there was no fracture and no cast had been applied, this patient's wound could be examined readily and easily. The clinical diagnosis of gas gangrene was made early. Radical local excision of deviatilized muscle, counter incisions, and thorough irrigation of the wound were possible. It is our opinion that the only way to make an early clinical diagnosis of gas gangrene is by examination of the wound and surrounding tissue, as was possible in this case.

Case IV. A private, age twenty, was wounded in the right arm by shell fragments on February 2, 1944. Because of profound shock it was necessary to administer 1,000 cc. of whole blood, three units of plasma and glucose solution. Guillotine type amputation was necessary elsewhere when the brachial artery burst.

On admission to this hospital on February 3rd at 6:00 P.M. the patient was irrational, the temperature was 102.4°F., and the pulse rate was 120 per minute. The stump of the right arm was open, red, edematous, tender and the end of the humerus was exposed. The muscle was discolored, there was a foul serosanguineous discharge and crepitus was elicited. Blood examination gave the following results: erythrocytes 2,900,000 per cu. mm., leucocytes 20,150 per cu. mm., hemoglobin 8 Gm.

Disarticulation of the shoulder joint was performed rapidly under gas, oxygen and other anesthesia. Counter incisions were made in the pectoral area. Three transfusions of whole

blood of 500 cc. each and several units of plasma were given. The patient failed rapidly and succumbed to the overwhelming infection.

On smears and cultures from the specimen gram-positive bacilli morphologically and culturally identified as Clostridium Welchii were demonstrated.

Comment. Although this patient was irrational on admission and the infection had spread to the shoulder girdle, after suitable supportive treatment had been given, a disarticulation of the humerus and incisions in the pectoral region were performed in order to give him the maximum chance of recovery. When the infectious process has spread beyond surgical access the prognosis is extremely grave.

Case v. A private age twenty-two years, was admitted to this hospital a few hours after being wounded by fragments in both lower extremities on February 22, 1944. The wounds of the thighs were deep, irregular, 10 to 12 cm. in diameter and muscle was exposed and macerated. There were smaller wounds of both legs and a comminuted fracture of each tibia.

Casts were applied following treatment on shock, cleansing and débridement of the wounds and reduction of the fractures. On February 24th the patient complained of severe pain in the left leg and he appeared toxic. The temperature was elevated to 102.6°F. but the pulse rate was only 98 per minute. The odor from the cast suggested the presence of gas gangrene. Swelling and cyanosis of the toes were observed.

Amputation through the left mid-thigh was performed under spinal anesthesia. Vaseline gauze was placed in the wound and the flaps were only partially closed. In the surgical specimen typical subcutaneous gaseous emphysema was demonstrated and direct smears and cultures revealed the presence of gram-positive organisms morphologically and culturally identified as Clostridium Welchii.

In the course of treatment 1,500 cc. of whole blood, 1,500 cc. of plasma, 140,000 units of gas gangrene antitoxin and 200,000 units of penicillin were administered. On February 25th examination of the blood gave the following results: erythrocytes 2,280,000 per cu. mm.; leucocytes, 11,400 per cu. mm.; and hemoglobin 5.5 Gm. Convalescence was satisfactory.

Comment. In the presence of a cast, pain around and below the wound, and swelling and discoloration of the toes in the lower extremity, or the fingers in the upper extremity, are signs suggestive of gas gangrene, as illustrated by this case. Also, in this case, the temperature was not in proportion to the severity of the infection.

Case vi. A seaman, age twenty years, was struck in the left leg by a shell fragment while aboard his ship on February 22, 1944. He sustained large wounds in which the muscles were torn and shredded, and comminuted fractures of the tibia and fibula. The wounds were thoroughly trimmed, débrided, and irrigated. Following reduction of the fractures by traction, a padded cast was applied to the leg and thigh.

On February 24th the temperature was 102.4°F.; the pulse rate varied between 120 and 140 per minute. Although the case had been split, the toes were cool and cyanotic. The odor of the profuse drainage was foul. Under a combination pentothal sodium and spinal anesthesia, amputation was performed through the lower thigh. In the specimen there was subcutaneous gaseous emphysema, and gram-positive bacilli, morphologically and culturally identified as Clostridium Welchii, were demonstrated.

Improvement was progressive but complicated by a mild febrile reaction. On February 26th the erythrocytes numbered 1,900,000 per cu. mm. of blood, the leucocytes 11,200 per cu. mm. and the hemoglobin was 8 Gm. The patient had received 3,500 cc. of whole blood, 2,250 cc. of plasma, 300,000 units of gas gangrene antitoxin and 300,000 units of penicillin. He was in good condition when transferred on March 3rd.

Case vii. A private, age twenty-one years, was wounded in the right thigh and both legs on February 1, 1944. His wounds were cleaned and a cast applied.

When the patient was admitted to this hospital on February 3rd he was pale and irrational. The temperature was 99.8°F.; the pulse rate was 112 per minute. The cast, which had been split, was saturated with dark, bloody, foul drainage. The erythrocytes of the blood numbered 2,630,000 per cu. mm., the leucocytes, 22,100 per cu. mm. and the hemoglobin

estimation was 9 Gm. Roentgenologic examination showed a comminuted fracture of the shaft of the right tibia. The tissue planes were separated by gas which had penetrated between the muscle bundles so that individual bundles were demonstrated.

Amputation was performed through the upper thigh under spinal procaine anesthesia. The foot and leg were found to be gangrenous. There was an extensive irregular, dirty, foul wound on the anterior surface of the leg from which gram-positive bacilli culturally and morphologically identified as Clostridium Welchii were obtained.

Before and after operation a total of 2,000 cc. of whole blood was administered; 80,000 units of gas gangrene antitoxin and 100,000 units of penicillin were also given. There was continuous improvement. When the patient was transferred on February 11th he was in good condition.

Comment. Most interesting in this case is the fact that the temperature on admission was only 99.8°F. although there was extensive gas gangrene of the leg as demonstrated both clinically and on roentgenologic examination.

SUMMARY AND CONCLUSIONS

1. In 984 consecutive fresh battle casualties there were seven cases of gas gangrene, an incidence of 0.71 per cent.

2. The lower extremity was the site of the infection in five cases (71.5 per cent) while the upper extremity was involved in two cases (28.5 per cent).

3. In all cases a gram-positive bacillus morphologically and culturally identified as Clostridium Welchii was found.

4. The incubation period varied from one and one-half to five days. The average time elapsed between the injury and appearance of symptoms was 2.35 days.

5. The wound in each case was large, deep, irregular and involved muscle. In five cases fractures were present and in one case amputation had previously been performed.

6. In nearly all cases pain was the initial symptom. Two patients were delirious on admission to this hospital. Local swelling, discoloration, crepitus and foul odor are early diagnostic aids. Evidence of toxicity appears late in the course of the disease.

7. A persistent elevation of the pulse rate was observed. The temperature was not a reliable index to the severity and extent of the infectious process.

8. The low erythrocyte counts and the low hemoglobin content were probably the most striking laboratory findings.

9. In one case the diagnosis was confirmed by the *x*-ray picture.

10. The treatment, both prophylactic and therapeutic, is primarily surgical. Early care of wounds and excision of devitalized tissue may reduce the incidence of gas gangrene.

11. In one case of gas gangrene excision of the wound gave satisfactory results. In six cases amputation was necessary. Wounds should be left open and vaseline gauze placed in them. Spraying of the stump with microcrystalline sulfathiazole, as recommended by many surgeons, is the practice in this hospital ship.

12. In patients with wounds of the extremities which are obscured by casts the early diagnosis of gas gangrene is difficult. The patients should be questioned frequently concerning the presence of pain. The cast should be examined for the odor characteristic of gas gangrene and swelling below the cast should arouse suspicion.

13. Multiple transfusions of whole blood were considered the most valuable single adjunct to surgery.

14. There were two deaths, a mortality of 28.5 per cent.

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Symmetrical gangrene is a trophoneurosis due to spasm of the arterioles with recurrent vasomotor attacks, characterized by local arterial syncope, usually bilateral and symmetrical, affecting the fingers and toes, and excited by cold or systemic states causing a superficial capillary anemia.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

CARCINOMA AND LYMPHOSARCOMA OF THE COLON

A CASE OF LYMPHOSARCOMA OF THE DESCENDING COLON

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THE term "malignancy of the colon" has been employed frequently by surgical writers and they usually have meant thereby carcinoma. Lymphosarcoma, however, does occur and this fact should be borne in mind particularly in suspected carcinoma with atypical manifestations. I have recently encountered a case of lymphosarcoma originating in the descending colon and thus my attention has been drawn for the first time to this extremely rare condition. In choosing a title for this paper I have included lymphosarcoma as one of the malignant colonic tumors rather than have it lost sight of in the general term "malignancy of the colon."

CARCINOMA OF THE COLON

The literature on this subject has increased enormously in the last five to ten years. I believe that this is largely due to the realization by the profession of the increasingly favorable results of its surgical treatment. Not only is the operative mortality being steadily lowered but the percentage of five-year cures is mounting. In the latter respect, cancer of the stomach makes a poor comparison indeed. It is understandable that a condition offering a better and better prognosis from improved diagnosis and treatment, should stimulate the interest of the surgeon and encourage him to still greater efforts to improve his treatment of this serious disease. The internist, too, who has in the past been perhaps too pessimistic over the outlook for a patient with cancer of the large bowel, has also taken a fresh interest and come to realize that an early diagnosis, and hence early operation mean a 50 to 60 per cent chance of a permanent cure. Cancer of the colon has an inherently better prognosis than cancer of the stomach on account of its slow growth and slow metastasis. Furthermore it can be radically removed together with a large section of bowel without impairment of function of the remaining bowel. Earlier diagnosis has been made possible by education of the laity in cancer in general and greater alertness of the profession in suspecting and discovering the disease early. Diagnostic aids, including *x*-ray and sigmoidoscopy have developed greater efficiency and thus made earlier diagnosis and thus earlier operation possible.

Perhaps the most important factor in the improvement of our operative results has been the greater attention paid to the preoperative preparation local and general. In the absence of acute obstruction which unfortunately is in many cases the first symptom that brings the patient to the surgeon, much can be done to prepare the colon for operation. Many patients have chronic obstruction and stasis which can be overcome by colonic irrigations, mild saline catharsis or possibly cecostomy. The dehydration so frequently present can be remedied by intravenous infusions; anemia and general weakness by transfusions. Such preparatory measures lasting sometimes several days improve our operative results very materially and should never be neglected. Operative technic has also improved and been made safer. Resection and immediate suture have given way in most clinics to stage operations which have a much lower operative mortality. Whether preliminary vaccination of the peritoneum has lowered the incidence of postoperative

peritonitis, is a debatable question. The internal use of sulfanilamide and more recently sulfaguanadine preoperatively is being tried in some clinics, apparently with a favorable effect on the prevention of postoperative peritonitis.

The most important factor in improving still further the prognosis is earlier diagnosis. Statistics show that even now with our improved diagnostic measures, the disease has usually been present for a year before reaching the surgeon. The problem is to shorten this period. The improvement in prognosis will well repay our efforts. As a preliminary to the discussion of diagnosis, it may be well to consider the important pathological factors of this condition and its chief clinical manifestations.

As regards incidence we find that it represents about 15 per cent of all cancers (U. S. Bureau of Census). It is almost as frequent as carcinoma of the stomach.

It is definitely a disease of later life. Pennington analysed 7,313 cases and found that 4,886 were in individuals over fifty years of age. The statistics agree that it is found more often in males than in females. Friedenwald[1] in his group of one-hundred cases had sixty-one males and thirty-nine females. Dixon[2] reported that in the Mayo Clinic there had been twice as many cases in males as in females.

Location. Carcinoma has been found in every section of the large intestine but it has a predilection for certain areas. Steindl reported 175 cases and Wilkie 243 cases with the following classifications:

Steindl	Per Cent	Wilkie	Per Cent
Sigmoid	49.1	Sigmoid	51.4
Cecum	20	Cecum	6.9
Hepatic flexure	8.6	Hepatic flexure	2
Splenic flexure	6.9	Splenic flexure	4.9
Ascending colon	6.3	Ascending colon	12
Descending colon	5.1	Descending colon	8.2
Transverse colon	4.4	Transverse colon	9.4

In Allen's series of 634 cases there were 53 per cent in the sigmoid and 25 per cent in the cecum and ascending colon. It is thus evident that the left colon, particularly the sigmoid is affected twice as often as the right colon. As in all cancer of the alimentary tract the favorite location is in areas subjected to traumatic or irritative influences, in natural or unnatural flexion angles and in the areas of spastic contracture. The sigmoid belongs in at least one of these categories. Another predisposing factor is the existence of a polyp in the mucous membrane. Some authorities claim that this is the most common starting point of the cancerous development. Another etiological factor may be chronic ulcerative colitis. The Mayo Clinic reported twenty-five such cases. There is a striking difference in the pathological status of carcinoma between those in the right and those in the left segment of the colon. This is due to anatomical and physiological factors. The right side of the cecum to the middle of the transverse colon has a function chiefly of absorption. The feces are liquid and they contain organisms of high virulence and extremely noxious toxins. The fluid contents are a good culture medium for bacteria. Furthermore this area of large intestine is rich in lymphatics, which means more absorption into the general system. The left side, on the other hand is the storage segment and contains formed feces from which the fluid has been extracted in the right segment. The lymphatic supply is scanty and the organisms are less virulent on account of the fact that the inspissated fecal collection is not a favorable field for growth of bacteria.

There are four common forms of carcinoma found in the colon: (1) The crater form *ulcer* which begins as an elevation of the mucosa on one side of the bowel and which grows in a circular direction surrounding and constricting the lumen. The edges pile up, overhanging an excavated ulcer; (2) a friable *cauliflower* growth rarely encircling the bowel but producing partial or complete obstruction by encroaching on the lumen; (3) polypoid or pedunculated

growths which do not produce symptoms of obstruction, and (4) small *constricting (napkin ring)* tumors usually of the scirrhus type. They rarely ulcerate, but infiltrate the bowel wall producing a small constricting ring.

The ulcerating tumors and the cauliflower-like growths are more frequently seen on the right side. The small annular constricting napkin ring growths are characteristic of the left side tumors, particularly in the sigmoid. On account of this condition and the fluidity of the feces, tumors on the right side rarely produce complete obstruction, whereas those on the left, particularly those in the sigmoid, cause a bowel closure very promptly. Cancer of the large intestine frequently spreads to other tissues or organs, such as the omentum, stomach, small intestine, parietal peritoneum, abdominal wall and bladder. The mesenteric lymph glands are usually the first sites of secondary growth. Metastasis in the liver rarely occurs in right-sided cancer, but is more common in those on the left side. In general, however, carcinoma of the colon has a low grade malignancy. It spreads very slowly and metastasis comes late. This means that for a long period in its development cancer of the colon remains a local lesion suitable for removal. In 210 cases which came to autopsy, 113 showed either no metastasis or only a few enlarged regional lymph glands. Perforation of the wall of the colon by the ulcerating growth sometimes occurs causing an abscess. Fistulous connection may also take place with a neighboring organ such as the small intestine, bladder, or stomach. Bargen,[3] in a study of 1,502 operative cases, noted an occurrence of perforation in 9.3 per cent.

As regards comparative malignancy, Grinnell has found four criteria for histological grading to be of value: (1) glandular arrangement, (2) invasiveness, (3) nuclear polarity, and (4) number of mitoses.

Duke classified carcinoma of the colon as A, B, and C, in degree of malignancy. The chances of a five-year survival without recurrence was four times as good for the class A cases as for the class C cases. The incidence of metastasis increases with the grades. The number of five-year survivals after operation was two and a half times higher when the glands were not involved.

Carcinoma of the colon in its early development does not give rise to definite clinical symptoms. In this respect it is at a disadvantage compared with carcinoma in other organs, and as compared with inflammatory lesions in the colon. In general a year has elapsed before the patient is operated upon. Occasionally, a carcinoma of the colon has been accidentally discovered in the course of an abdominal operation for some other lesion. The delay in making the diagnosis may be shortened by education of the laity in the importance of early consultation of a physician for unusual gastrointestinal symptoms. The physician for his part should emphasize in his mind not those symptoms which are pathognomic of carcinoma of the colon but rather the indefinite ones that *might* be caused by carcinoma. In most cases these may be caused by some other condition and a thorough examination may be negative for carcinoma. Nevertheless the wise physician will insist upon a thorough examination of every patient particularly over forty who has persistent abdominal symptoms even though vague and slight in character, which do not disappear under the usual dietetic and medicinal measures. The symptoms may consist of a feeling of abdominal pressure, especially on the right side, colicky pains or gaseous distention. Loss of appetite which usually accompanies all gastrointestinal carcinoma together with a feeling of pressure in the upper abdomen may lead the physician to think first of a stomach condition, which with a negative *x*-ray of the stomach is diagnosed as an inflammatory disease of the stomach and treated as such without benefit. Of more importance is painful distention of the cecum and ascending colon which may lead to the diagnosis of appendicitis and operation. This error in diagnosis is more

likely to occur if a history of increasing constipation is not taken into consideration. This painful distention on the right side should be looked upon as an important sign, especially in elderly individuals and not immediately diagnosed as appendicular in origin. It should indicate the necessity of careful examinations including sigmoidoscopy and *x*-ray. The appearance of anemia in an elderly person is significant especially of carcinoma of the right colon. Such an anemia should not be treated as such until malignancy of the colon has been excluded.

The usual symptoms which bring patients with carcinoma of the colon to a physician are persistent abdominal pain, visible blood in the stools or changes in the bowel habit particularly increasing constipation. Each of these symptoms are an indication for a thorough examination. Lahey[4] found a history of a change of bowel function in 80 per cent of his cases of carcinoma of the left colon and rectum. Colicky pains, especially in an elderly person, can be caused by beginning obstruction. Increasing constipation in the elderly patient should be looked upon with suspicion and not treated by stronger cathartics, until carcinoma has been eliminated. Alternation of constipation and diarrhea occurs in a certain percentage of the cases, especially in the pelvic colon. Lahey[4] found it in 8 per cent of one hundred cases. Stools should be examined for visible and occult blood. Active bleeding is rare. Blood from a carcinoma of the right colon is usually mixed with the stool but when originating from the left colon is attached to the stool or appears as bloody mucus. Friedenwald[1] found blood in the stools of 24 per cent of his cases as an early symptom and in 52 per cent of the later cases.

The presence of a palpable tumor is usually a late symptom. It is more often in carcinoma of the cecum and ascending colon. This is due to the fact that this area is more easily palpated and furthermore the right-sided tumors are usually larger.

As the pathological status of tumors of the right and left colon shows marked differences so does the symptomatology. Dyspeptic symptoms are more characteristic of right-sided carcinoma. This is frequently associated with pain or discomfort on the right side suggesting appendicitis or cholecystitis. In fact, many patients are operated upon with these diagnoses. In other cases anemia is the first symptom that brings the patient to the physician. Such an anemia which cannot be otherwise explained should be looked upon with suspicion especially in an elderly individual and calls for a thorough examination of the entire colon including *x*-ray. This anemia is not caused by loss of blood but is toxic in origin. In a third group of cases the presence of a tumor in the right iliac fossa is the first symptom and may be first discovered by the patient. On the left side obstruction is the outstanding symptom. It has been estimated to occur six times as often as on the right. This is easily understood when we consider first that the feces in the left colon are more solid and thus have greater difficulty in passing even a moderately obstructed lumen. Furthermore, as has been stated in connection with the pathology, left-sided carcinoma is often of the constricting (napkin ring) type which produces annual closure of the bowel.

The obstruction may be acute and sometimes is the first symptom of the disease. Acute total closure of the bowel is, however, exceptional. Authors differ considerably in the percentage of cases with acute obstruction. Figures range from 5 per cent (Rankin[5])to 27 per cent (Finsterer[6]). This divergence may be partially explained by a different interpretation of the term "acute obstruction." Some surgeons mean thereby only complete obstruction and others include cases of incomplete obstruction. Acute partial closure is more common and should be treated in the same way as complete obstruction, viz., by immediate

operation. Acute complete obstruction should be diagnosed when there is total stoppage even to the passage of flatus with marked distention of the abdomen, hyperactive peristalsis causing spastic and even visible contractions of the afferent bowel and vomiting later becoming fecal. Such an acute obstruction may come out of a clear sky or it may be grafted on to a chronic obstruction. Cases are on record in which barium from a gastrointestinal series has plugged the colon at the site of an annular lesion and thus precipitated an acute obstruction. As a general rule obstructions from carcinoma of the left colon are slow and likely to be progressive, causing gradual deterioration of health by intoxication and dehydration. Patients in such a condition react very badly to operative procedures even of a minor character and when possible should be first brought into a more favorable state before any operation is attempted. It is often astounding to see the improvement that results from the medical measures that are used to overcome the obstruction, intoxication and dehydration.

The diagnosis of carcinoma of the colon is comparatively easy in its later stages, but may be very difficult in its early development when surgery offers the greatest hope. There being no characteristic symptoms of beginning carcinoma of the colon the physician should not rely upon any one symptom, but rather upon an impression based on a number of factors in the history, symptomatology, physical examination, laboratory reports and *x*-ray examinations. In the history, age of the patient, the mode of appearance of abnormal symptoms (perhaps in a previously healthy person) loss of weight, anemia, indefinite dyspeptic symptoms, periods of obstruction, blood in the stools, change in bowel habits, are all important factors to be carefully considered. The presence of such a group of manifestations calls for a careful and complete physical examination. Here the presence of a tumefaction is, of course, of the greatest importance. Such a tumor is most likely to be found in the region of the cecum or ascending colon. It must be remembered that a tumor in the cecal region may be caused by a chronic appendicular abscess. There is the same irregularity, firmness and low degree of tenderness that is found in a carcinoma of the cecum. This mistake has been made many times. The opposite can also happen. What was thought to be an old appendicular abscess has turned out to be a carcinoma of the colon with secondary inflammatory changes. The laboratory may show microscopic blood in the stools and a definite anemia. A rectal examination should never be neglected and gives invaluable information regarding the presence or absence of a neoplasm in the rectum and rectosigmoid. *X*-ray examination should follow and may prove conclusive. One should not, however, rely upon one examination, particularly a negative one. The *x*-ray enema should be first employed as any obstruction already present might become acute and give rise to alarming symptoms if a gastrointestinal series was the first procedure.

It may be said in general that an important positive *x*-ray sign of a carcinoma is a narrowing found constantly present at a definite point in the colon which remains visible in spite of manipulation or the insufflation of air after the expulsion of the barium enema. A second positive sign is a persistent irregularity in outline of the colon especially when accompanied by spasm. Distention of the colon with air after the barium enema has been expelled sometimes brings out more clearly a lesion that has been masked by the barium. Complete reliance must not be placed on a negative *x*-ray examination if other symptoms strongly suggestive of carcinoma of the colon, persist. It has not infrequently happened under these circumstances that an exploratoty operation has revealed a carcinoma in spite of repeated negative *x*-ray examinations. The diagnosis of simple spasm of the colon should not be made on the basis of a single *x*-ray examination.

Before the second examination atropin should be given. If the narrowing of the lumen is still present, the stricture is probably organic in nature. Lesions of the rectosigmoid junction are frequently not visualized by *x*-ray. For this reason sigmoidoscopy should be employed in addition to *x*-ray when malignancy is suspected in this area. Diagnosis of carcinoma of the colon will be made at a much more early date if middle aged and elderly patients are educated to seek advice for any change in bowel function, especially increasing constipation with or without mucous diarrhea. These patients should also be educated to submit readily to *x*-ray examination with barium enema and to proctoscope examination. Unfortunately the cost of *x*-ray examination is still high. It should be brought down to such levels that examinations can be made as a routine in all doubtful cases. There will of course be a great many negative examinations if this policy is carried out, but on the other hand physicians must realize that only by routine examinations of all kinds can they discover early cancer of the colon.

In considering the prognosis of carcinoma of the colon it should be noted that there are some factors that are favorable to successful surgical treatment and others unfavorable. As already emphasized carcinoma of the colon develops slowly and hence if discovered at a reasonably early stage is capable of successful removal. Furthermore it usually remains localized for several months thus making radical and complete eradication feasible even in a late stage. Finally carcinoma of the colon involves an organ, a large section of which can be removed by a comparatively simple and safe technic without impairment of function. Among unfavorable factors in prognosis the most important is the fact already emphasized in the symptomatology, viz., that there is usually a latent period in which there are no characteristic symptoms on which a definite diagnosis can be made. As a result, a year has usually elapsed before the patient comes to operation. The loss of this valuable time constitutes a serious handicap at the start of the radical treatment. Another handicap is the infectious content of the bowel combined with the tendency to gaseous distention which renders primary anastomosis dangerous.

The prognosis has undoubtedly improved greatly in recent years and for this several factors are responsible. In the first place there is earlier recognition and hence earlier treatment. Prognosis following operation has been greatly improved by the more general recognition by surgeons of the immense importance of preoperative treatment of the patient and by greatly improved technic of operative and postoperative care including the introduction of the much safer multiple-stage procedures. The prognosis of carcinoma of the right colon is better than of the left. Carcinoma of the right colon seldom gives rise to liver metastasis while this is not an uncommon complication on the left side. Furthermore, operation on the right colon is less complicated and safer. Age has an important influence on the prognosis. It is very malignant in the young. Carcinoma in a patient sixty years old has a better prognosis than in one fifty years old. This is largely true because metastasis is slower as age advances.

The diagnosis having been made the first question to be decided by the surgeon is that of operability. Here again the last few years have seen a marked improvement. Formerly, the diagnosis was made very late in the disease and a majority of the cases had become inoperable on account of extensive local and general metastasis or cachexia. Finisterer[6] has recently reported an operability of 79 per cent of the cases applying for radical treatment. Babcock estimates operability at 60 to 80 per cent. The surgeon is not seldom surprised to find on opening the abdomen that a tumor which on external and *x*-ray examination had appeared very large and apparently involved an extensive area is actually localized and capable of complete

removal. It may be necessary to resect adjacent structures such as the stomach or small intestine which have become invaded. A preliminary colostomy with delay in carrying out the radical operation will often improve the local condition about the tumor. The inflammatory infiltration in the intestinal wall and adjacent structures subsides, the growth diminishes in size and becomes more movable and complete excision becomes possible.

Except in the case of acute obstruction all operative measures should be delayed until the patient has been put into a condition to withstand their effects. Even a colostomy for partial obstruction may prove fatal in a weak, dehydrated individual who has suffered for a long time from chronic obstruction, anemia and inanition. When delay is possible, preoperative measures should be carried out in full. If partial obstruction is present, this can usually be relieved by repeated saline enemas, mild catharsis and hot abdominal stupes. If there is no obstruction present, the intestines should be emptied of fecal matter by a combination of mild catharsis and colonic irrigations. The patient should be given a high caloric, non-residue diet. The water balance should be re-established by saline, bicarbonate or glucose in large quantities given preferably intravenously or by clysis. A diminished glycogen content of the liver may require the administration of sugar. Vitamin therapy may be indicated. In case anemia is a symptom one or more transfusions of blood should be given just before operation.

A discusson of the various operative methods employed for the removal of carcinoma of the colon will not be attempted in this paper. Certain general principles, however, will be laid down. Here again a distinction should be made between the right and left half of the colon. Primary resection of the right half is much safer than of the left. This procedure on the left side has been largely given up on account of the danger of leakage at the point of suture. This difference is chiefly due to the fact that the solid contents of the distal colon tend to put too much strain on the suture line. A preliminary right-sided colostomy diminishes this danger to some extent. The general custom has been to perform on the right side a one-stage resection of the colon. Of late some surgeons prefer a two-stage operation on account of greater safety. Allen for example reported seventy-three right-side resections in one stage with twenty per cent mortality and eighteen two-stage resections with 11 per cent mortality. On the left side some form of exteriorization method is the usual procedure. This takes the form of the Mikulicz technic or some modificaton.

The present end results of operation are distinctly encouraging. Dixon reports from the Mayo Clinic 52 per cent of the patients operated upon for carcinoma of the cecum alive and well five or more years later. In carcinoma involving the colon from the cecum to the sigmoid, the five-year cures were 48 per cent. As regards operative mortality Rankin has recently reported 130 cases with 8.4 per cent mortality. The figures both for operative mortality and five-year cures given by the more experienced operators certainly show a great improvement over the statistics of twenty years ago. This gain is due to (1) earlier diagnosis and hence earlier operation, (2) more thorough preoperative measures, and (3) improved and safer technic. Carcinoma of the colon has become one of the most hopeful of the intra-abdominal malignancies and bids fair to become even more so now that it is receiving increasing attention from the physician, the surgeon and the laity.

LYMPHOSARCOMA

Lymphosarcoma of the intestine is rare. Reichel found thirty-three cases in 54,000 autopsies. Nothnagel found nine cases in 21,358 autopsies. Involvement of the colon is less frequent than that of the small intestine. Ullman,[7] in a study of 126 cases found the small intestine the primary site in seventy-seven cases, the colon including

the cecum in thirty-two cases and the ileocecal region in eight cases. The cecum was the primary site in seventeen cases, the ascending colon in two, the transverse colon in one, the descending colon in two, and the sigmoid in four. The right colon is apparently more often involved than the left.

Authorities agree that the disease is more common in males. In Ullman's series there were ninety males and thirty-six females. In contrast with carcinoma it is found most commonly in the first four decades. It is especially common in childhood. Cases in older people do occur. Werden reported a case in a woman eighty-four years old. The case reported in this paper was a woman of seventy-three. The cases occurring in childhood have a very rapid course. Those in the older individuals are characterized by a very slow course. One reported case states the patient lived for twelve years.

The pathological origin of the disease as stated by Ewing[8] is in the lymphoid tissue of the intestinal wall (submucosa). The process here spreads laterally, and invading and destroying the muscular coat, may cause a bulging of the mucosa into the lumen and a protuberant swelling beneath the serosa. Perforation of the mucosa causing ulceration is not the rule. Likewise perforation of the serosa is unusual. Adhesion, however, with adjacent structures (omentum and other intestines) may occur. Cicatricial narrowing of the intestines as in carcinoma does not occur but rather a dilatation of the wall as in aneurysm owing to loss of function of the muscular layer. Stenosis is rare. Metastasis takes place early in the mesenteric lymph-glands and omentum. These secondary tumors may reach a large size and overshadow the original growth in the intestinal wall. A chronic peritonitis with fluid is not infrequent.

The symptoms caused by the development of a lymph sarcoma of the intestines are not characteristic. The diagnosis is scarcely ever made before operation or autopsy. General symptoms such as anemia, loss of strength and of weight may be the first evidences to the patient and physician. In other cases local symptoms may be the first to appear, such as abdominal pain sometimes of a colicky nature. This pain is not associated with the intake of food or disturbances of bowel function. There may be constipation or diarrhea or alternation of each. Acute obstruction of the intestine is rare and is caused by intussusception, adhesions or plugging of the lumen. The presence of a mass in the abdomen, particularly the lower segment, is a common finding and may be the first thing that attracts the attention of the patient or physician. Anemia is a constant symptom and may be accompanied by a moderate leucocytosis and increased polynuclear count.

As already stated the diagnosis is hardly ever made before operation. Even *x*-ray is not very helpful. Where the small intestine is involved, there may be seen some dilatation of loops of small intestine with a tendency to local stasis. If the colon is involved, a barium enema may show a deformity or filling defect. Exploratory laparotomy is the usual method of making the diagnosis and should always be employed when there is a palpable tumor with evidences of intestinal obstruction and particularly when associated with an unexplained secondary anemia with loss of weight and strength. The best hope of cure lies in early and radical operation. Resection of the portion of intestine involved has been followed in some cases by complete cure. When metastasis in the mesenteric lymph glands and omentum have occurred with adhesions and possibly ascites, radical removal is impossible. In such cases some form of palliative operation will be done, such as short circuiting or permanent colostomy. If the obstructive symptoms are not marked simple closure of the abdomen may be the procedure of choice. Irradiation is advised by some authors both after radical, palliative and simple exploratory operation. Theoretically

this seems indicated on the ground of its favorable effect upon lymphosarcoma in general. Practically, the results have not been encouraging. Many of these patients are very debilitated and do not react well to this treatment. Others have shown no local improvement. It should not of course be considered a substitute for radical surgery.

The following case of lymphosarcoma of the descending colon has recently been under my care, and the rarity of the condition would seem to justify a report of the case:

CASE REPORT

The patient was a female, seventy-three years of age, from whom I had removed a simple ovarian cyst five years before. She had been in good health since the operation when she consulted me on account of a swelling in the lower left quadrant of the abdomen which had been discovered in another city a few weeks before, and for which an operation had been advised. For the preceding year she had been treated for anemia, constipation and loss of weight and strength. She had had some pain in the left lower quadrant.

Examination showed a thin anemic woman with a median laparotomy scar. The abdominal wall was very thin and relaxed and a hard irregular swelling the size of a small orange could be easily felt in the region of the lower descending colon. *X*-ray showed no definite obstruction of the intestine but some irregularity in the wall of the colon. On account of her age, anemia, loss of weight and strength and the presence of a tumor, a diagnosis of carcinoma of the descending colon, was made and operation advised. Operation revealed a hard nodular tumor involving the descending colon and adherent to the parietal peritoneum. There was a secondary tumor the size of an English walnut in the omentum. There were enlarged glands in the mesentery. A portion of the left rectus muscle adjacent to the growth was the seat of a hard infiltrating mass. There was considerable free fluid in the peritoneal cavity. There was no matastases in the liver. As the tumor was plainly inoperable, the tumors in the omentum and rectus muscle were removed for pathological examination, and a colostomy performed. The pathological report on the secondary tumor masses removed was metastatic lymphosarcoma. The patient unexpectedly gained in weight and strength after leaving the hospital and resumed active life. Her anemia responded remarkably to weekly injections of reticulogen. The original tumor did not increase in size and the ascitic fluid did not noticeably accumulate. She gave one the impression that she might live for many years. Two years after the operation, however, an acute pneumonia caused her death after a week's illness.

This case resembles closely those that have been reported. In the first place the course of the disease in the aged is, as in this case, usually slow. One reported case was twelve years. In the second place the first symptom for which she was treated was increasing anemia and loss of weight and strength. In the third place the pathological process included regional metastasis in the mesenteric glands, omentum, parietal peritoneum and overlying muscles. In the fourth place, a diagnosis was first made after exploratory operation and pathological examination of the specimen.

SUMMARY

Both carcinoma and lymphosarcoma of the colon are described and their treatment outlined. Although much rarer than carcinoma, lymphosarcoma should be thought of especially in non-typical cases of the former. The improved prognosis of carcinoma is stressed and still greater improvement hoped for from earlier diagnosis, more thorough preoperative preparation, improved operative technic and chemotherapy. A case of lymphosarcoma of the descending colon is reported and its pathology, symptomatology and prognosis compared with those of carcinoma.

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HEALING OF INTESTINAL ANASTOMOSIS

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THE purpose of this presentation is to describe the essentials of the process which establishes continuity of the gastrointestinal tract, following suture of wounds or anastomosis. The more common factors causing failure are also presented.

In order to study the problem, pyloric resections, gastroenterostomies and intestinal anastomoses were performed on more than one hundred dogs. Serosa to serosa approximation by suture was performed on over fifty rabbits. Varying technics were used in suturing, some specimens being made with meticulous aseptic care, others being contaminated with bowel contents. To these preparations has been added such material from the human as came to hand in the course of routine work. The latter has been sufficient to substantiate experimental results.

There are a great many problems peculiar to the individual case of gut anastomosis or repair. This investigation is limited to the following considerations: (1) Those accomplished without contamination by virulent organisms; (2) those in which unattenuated organisms may produce infected areas, and (3) those attempted in the presence of deficient blood supply.

A common method of suturing the intestinal tract has been to sew the mucosa, submucosa, muscle and the serosa in three separate layers. However, the object of all methods has been to invert the edges in order to place serosa against serosa and to hold other tissues in continuity. The description of the healing in this presentation is based upon experimental study of intestines sutured with one continuous silk or chromic catgut inverting stitch, including mucosa, muscularis and serosa. Another silk stitch included serosa only. (Fig. 2, insert.)

Chromic catgut is desiccated in the process of making tissue sections and becomes bone-like in hardness. Both stitch and tissue structure about the stitch are fragmented when cut with the microtome. If the stitch is pulled out before cutting, distortion occurs. This must be recognized when such sections are studied.

HEALING OF NON-INFECTED ANASTOMOSIS

By non-infection is meant the absence of live virulent organisms capable of growth to the extent of injuring the tissue. No anastomosis is accomplished without some bacterial flora of the intestinal tract reaching the line of anastomosis. In the stomach and small intestine these organisms are seldom capable of injuring the tissues unless gross contamination occurs. The flora of the colon more often is capable of doing this and a greater hazard of infection is always present. The effect of this on healing of the wound will be described in the next section. Here we assume its absence.

When the gut wall is inverted by suturing, a triangular chink is formed just outside of the line of anastomosis on the serosal side. The irritation produced by suture material and needle puncture causes an exudate of plastic lymph into the chink as well as between the tissue surfaces.[3] Within fifteen minutes fibrillar fibrin begins to form in the exudate, binding the surfaces together and making them watertight. (Fig. 1.)

A note of explanation may be necessary regarding the fundamental principles of this process. Plastic lymph is the liquid exudate from injured tissue. Sometimes it is designated as serum, but it is more than that, since fibrinogen and the other

elements of coagulation are present. In this it resembles blood plasma but that it is identical to blood plasma has not been shown.

As varying degrees of irritation may occur in injured tissue, variations in the structure of fibrin may occur so that we find fibrils uneven in diameter and sometimes having a nodular surface giving them the appearance of a short string of beads. Unless the fibrin structure varies too greatly from the fibril type, its change to collagen fibrous tissue is not materially affected.

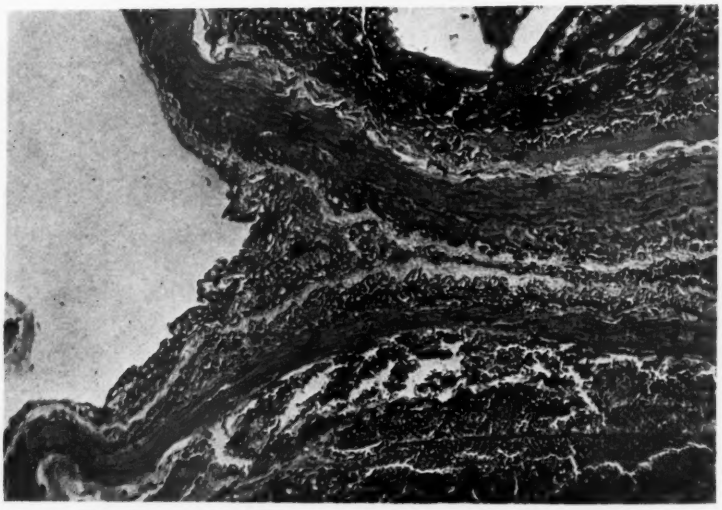

FIG. 1. Two loops of small intestines of a live rabbit sutured together with a few silk stitches. After thirty minutes the animal was killed and the specimen fixed. At *a* can be seen well developed fibrillar fibrin filling in the chink between the bowel wall at *b,b*.

Fibrillar fibrin is an arbitrary term used here to describe bundles of fibrils which develop in plastic lymph. Maximow[9] says about this process, "The physical factors involved in this change are the aggregation of a protein colloid of the normal plasma into threads . . . no ultimate analysis of the phenomenon has been reached."

There may be single fibrils present in the plasma of blood clot or the exudate of injured tissue but the predominant arrangement is bundles of fibrils. (Fig. 2.) The latter become minute strands of collagen recognized as connective or repair tissue.[2]

If the process of fibrin formation is disturbed by irritating substances, the character of the fibrils may be changed. Severe interference may cause an "aggregation of the protein colloids" into small granules and these do not become collagen. This is called granular fibrin. (Fig. 3.) Granular fibrin forming during the healing of a wound must be removed by phagocytosis and absorption before fibrillar fibrin is formed and healing completed.

The fibrin bundles always stretch across the chink and between the tissue surfaces parallel with the lines of stress. A few hours later the fibrin bundles are numerous and the line of anastomosis is plugged effectively by them. Even the most rapid operator may often see this grossly when he has finished a gastroenterostomy if he examines the first stitches he placed in the serosa.

Fibrillar fibrin laid down in this fashion is invaded by mononuclear cells and these elongate along the fibrin bundles as young fibroblasts.[2,5,9,11] Chemical change takes place in the fibrin and by the seventh day the fibrillar fibrin becomes indistinguishable from collagenous fibrin. (Fig. 4.) Thus we have union between the serosal surfaces produced by new connective tissue.[5,6]

The muscle layers are united by reparative tissue in like manner. The process is sometimes disturbed by the exudate of blood corpuscles but healing takes place in the same way except for the phagocytosis of débris made up of the solid elements of the blood and possible contaminating particles from the intestinal lumen.[8,10]

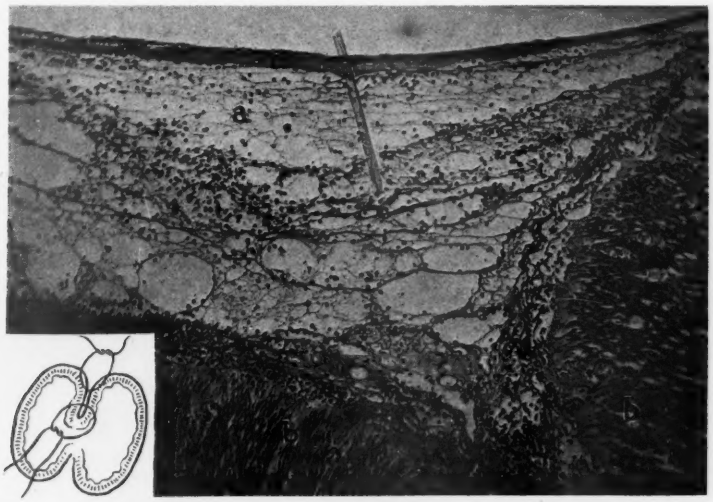

Fig. 2. Twenty-four hour specimen showing development of fibrillar fibrin, *a*, in chink between two loops of dog intestine, *b,b*, sutured together. Infiltration of monocytes and a few polymorphonuclear leucocytes has begun. At *b,b* edematous swelling of the intestinal wall aids in pushing them together, thus aiding the sealing of the anastomosis. Insert is schematic outline of technic used in suturing.

The mucosas unite by continuity. The mucosal surfaces are not separated by scar tissue and in anastomosis of two hollow viscera whose mucosas are composed of different cell structure, glands may be seen containing both types of cells at the point of union. From two to three weeks usually is required for the entire mucosal line of anastomosis to become continuous.

During the first few days following anastomosis there is hyperemia, general edema and cellular infiltration in the tissues of the sutured area. This is always quite marked in the loose tissue of the subserosa. The swelling produced by this aids in pushing the serosal surfaces into closer approximation and thus aids in closing the chink along the line of anastomosis.

The general swelling throughout this area greatly enlarges the volume of tissue and by its size may produce a brawny thickening of the ring amounting to partial occlusion of the lumen. (Figs. 2 and 4.) After a week the swelling begins to subside. In another ten days it has largely disappeared. (Fig. 5.) Gradually there is shrinkage of the repair tissue and atrophy of surplus muscle and mucosa and the ring produced by inversion of the gut wall nearly disappears.

Sutures, if of absorbable material, gradually disappear from the tissues. Permanent sutures of linen or silk seldom stay in the tissues. As atrophy occurs they are brought near the gut lumen. The irritated area they create is subject to infection and they soon penetrate the mucosa and are carried away with the intestinal contents.

HEALING OF INFECTED ANASTOMOSIS

Infection with virulent organisms causes granular fibrin to form—an excellent media in which organisms may function and grow. (Fig. 3.) The wound may be temporarily sealed by the granular fibrin; but before permanent union of the tissues takes place, it undergoes resolution as described above and the tissue surfaces

are freed. The wound then may be easily pulled apart and leak if the suturing and consistency of the tissue is not sufficient.

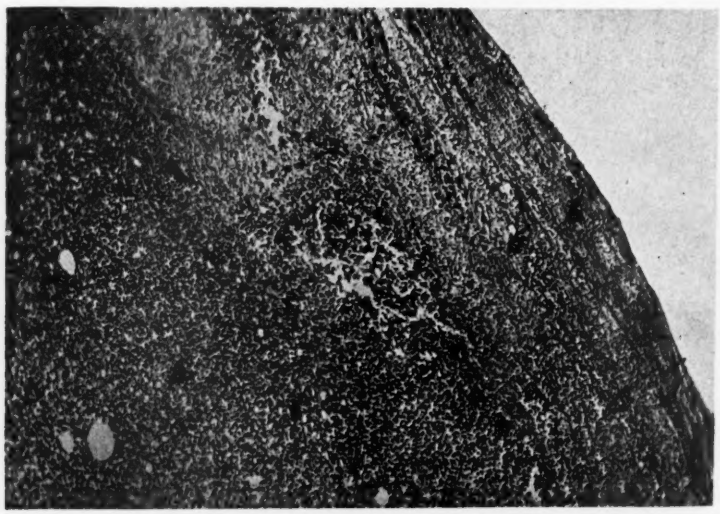

FIG. 3. Two-day specimen of line of anastomosis between two loops of dog intestine. Contamination with resulting violent irritation has caused granular fibrin to be formed at *a*. Near the surface at *b* a good grade of fibrin has developed. Between these two areas a poor grade of beaded fibrin is seen, *c*. The granular fibrin must be absorbed and replaced; *b* and *c* will develop.

The dissolution of this union occurs most often between the sixth and eighth days.

Irritation of the omentum and surrounding viscera may result in adhesions which keep the intestinal content from escaping into the free peritoneal cavity. By secondary healing the tissues may become united. Otherwise the patient succumbs to general abdominal infection.

ANASTOMOSIS WITH INSUFFICIENT BLOOD SUPPLY

In anastomosing viscera, the blood supply may be disturbed to such a degree that the anastomosed tissue does not contain a sufficient blood supply for its vital need. This may be caused by ligation of arteries or sutures so firmly placed as to result in ischemia. The result is, of course, gangrene of the tissues.

To demonstrate this, resections of the dogs' pylorus and part of the fundus were made, resecting the stomach at a level just above the large middle branch of the gastric artery loop on the lesser curvature. This created an area of stomach supplied with blood only through anastomosing vessels. A posterior Pólya type of anastomosis then was made to the jejunum closing the stomach near the lesser curvature, with large stitches pulled unduly tight. Ischemia of the area was the result.

Dogs operated upon in this way recovered from the operation and improved rapidly until by the fifth day their condition appeared all but normal. These animals invariably died rather suddenly between the sixth and eighth day.

Autopsy showed an area of gangrenous necrosis in the tissue where sutures were pulled too tight. This area had sloughed and gastric contents escaped into the peritoneal cavity. No adhesions were found about such areas. The stomach content had diffused throughout the abdomen. Violent peritoneal reaction was present.

Specimens of this type were studied at intervals of twenty-four hours. An exudate of plastic lymph developed in the wound following suture. Fibrillar fibrin formation began but soon underwent resolution as necrosis developed in the ischemic area. Fibrillar fibrin was never found in the presence of necrotic

tissue. No protective adhesions were developed to isolate the area of impending gangrene.

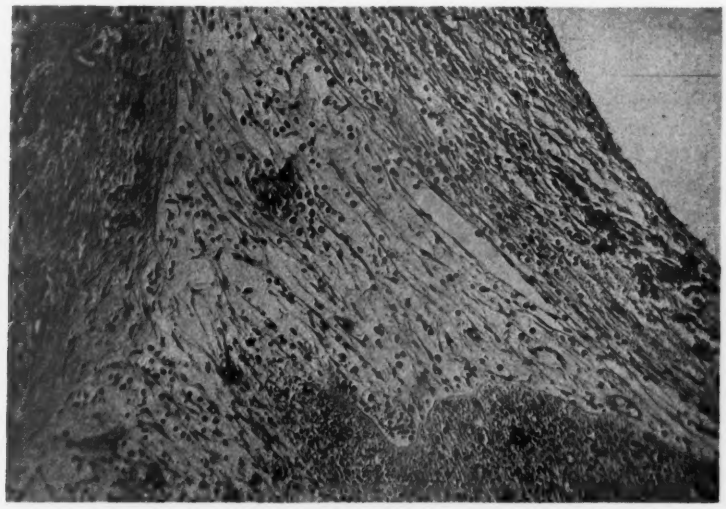

Fig. 4. Seven-day specimen of healing line of anastomosis between two loops of dog intestine. At *a* is a patch of poor fibrin not entirely organized. New blood vessels, *b*, are well formed; *c,c* is the subserosa of the intestines. The monocytes have taken on the exact appearance of fibroblasts.

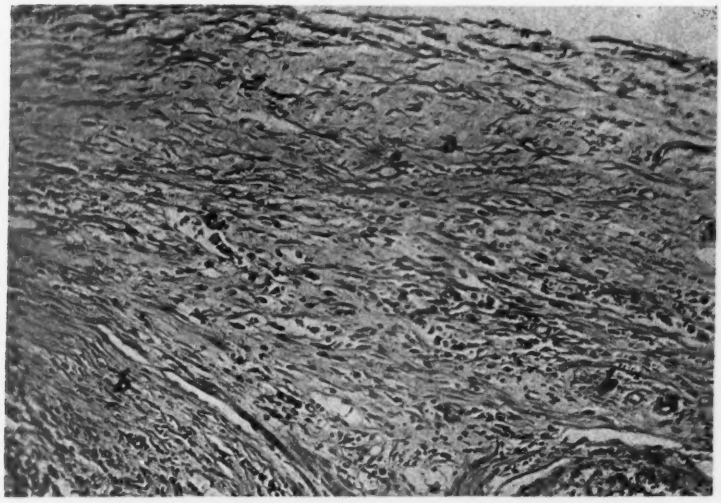

Fig. 5. In this eighteen-day specimen a mature type of fibrous tissue has developed at the line of anastomosis, *a*; *b,b*, is the wall of the intestine. Many small blood vessels are present, *c,c*. Edema has disappeared.

COMMENT

Our most tangible ally in establishing a watertight anastomosis of intestines is fibrillar fibrin. Thus its development is to be encouraged. Lack of contamination with virulent organisms and adequate blood supply favors the formation of fibrillar fibrin.

It is generally taught that suturing must be done in a manner that will make the line of anastomosis watertight. This is unnecessary and too vigorous attempts to accomplish it may produce localized areas of ischemia. This is particularly likely to occur where the blood supply has already been decreased. Necrosis may result. Since adhesions do not form about the gangrenous tissue, resolution of the necrotic area may result in the escape of

bowel contents into the free peritoneal cavity. The sixth to eighth postoperative day is the usual time for this to occur. Patients usually suffer intense shock at this time.

Sutures should be so placed as to fix the tissues in approximation but any small areas open between sutures are promptly closed by fibrillar fibrin. Within fifteen to thirty minutes after sutures are in place fibrin is formed and the whole line of anastomosis sealed by a plug of this fibrin. Induration and swelling in the intestinal wall soon takes place and tends to approximate the surfaces tightly.

This is of importance when considered in the light of postoperative care. Patients may be given water by mouth six hours after a gastroenterostomy or other bowel anastomosis if the wound is not contaminated with material likely to harbor virulent organisms. In four days soft diet may be given if the general condition does not contraindicate it.

There need be no fear that peristalsis will break up the formation of new connective tissue. In the series of experimental pyloric resections in which anastomosis of the stomach to the jejunum was made some animals were fed chicken bones on the third day. Only one row of chromic catgut and one of fine silk was used. No animals showed clinical evidence of leakage of intestinal contents, at the time or pathological evidence when autopsied later.

The reaction that takes place in the tissues about the anastomosis causes enough swelling to obstruct the bowel partially in some cases. This may account for some of the vomiting seen following anastomosis. If the patient can be sustained by fluids given parenterally, improvement is nearly always seen by the tenth day. The swelling has greatly subsided by this time. Swelling of the tissue should be kept in mind when making stomas of any kind in the gastrointestinal tract. Failure to do this and to recognize its significance sometimes has caused the surgeon needlessly to reopen the abdomen a few days following operation when obstruction has developed.

SUMMARY AND CONCLUSIONS

1. Gastric resections, gastroenterostomies and anastomoses were done on a hundred dogs and fifty rabbits creating varying conditions of asepsis and blood supply. Studies were made of the process of healing under these conditions.

2. The line of anastomosis is made watertight by the development of fibrillar fibrin fifteen to thirty minutes after the sutures are put in if the tissue is uncontaminated by virulent organisms.

3. The presence of virulent organisms causes development of granular fibrin. When resolution of this occurs the anastomosis may be pulled apart or leak.

4. Insufficient blood supply in an area of anastomosis results in gangrene. Fibrillar fibrin is not produced in the presence of necrotic tissue. This should be stressed particularly to emphasize the importance of handling tissues delicately and of avoiding tight sutures. No adhesions form to wall off a gangrenous area. When dissolution of tissue occurs, bowel, contents escape into the peritoneal cavity.

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AIRE-LITE*

A NEW PLASTIC MEDIUM OF CLINICAL IMMOBILIZATION

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THE evolution of methods of immobilization has been a notable feature of clinical surgery. Modern technics to attain this end were inaugurated by Suetin's "starched apparatus" about 1834, and culminated in the plaster-of-Paris bandage which was invented by Matthysen in 1852. Thereafter, despite Suetin's bitter opposition in favor of his own method, the superiority of the plaster bandage was soon established. Since that time surgeons have achieved such excellent results with plaster that some of its disadvantages have been largely overlooked. Among these may be mentioned its relatively heavy weight and bulk, poor penetrability to *x*-rays, general untidiness attending its application, wearing and removal, occasional trickiness of setting characteristics because of the qualitative differences which exist between the various grades of plaster made, poor ventilation and poor resistance to moisture and tendency to absorb moisture of all kinds, which results in irritation of the skin, discomfort to the patient and softening of the plaster cast itself. More recent improvements in the manufacture of plaster-of-Paris bandages and splints and plaster technic have overcome some of these disadvantages to a lesser or greater extent. Substitutes for plaster have appeared on the market from time to time for the same reasons but none of these has been widely accepted. It is the purpose of this preliminary report and discussion to introduce "Aire-Lite," a new plastic medium for clinical immobilization.

Some years ago Dr. Roger Anderson conceived the principles of utilizing a plastic fabrication in the form of a dry, open-meshed and flexible bandage, which could be applied to the body, then sprayed with a volatile setting liquid to form a rigid supporting structure. He succeeded in designing, developing and applying this principle for clinical purposes. In its present form, Aire-Lite is a stockinette form of bandage made by loosely knitting a yarn composed of a mixture of cellulose acetate and a regenerated cellulose rayon. (Fig. 1.) The knitted bandage is then processed to control shrinkage, setting and drying characteristics. This processing leaves the bandage flexible and dry in which form it is applied to the body. When this bandage is in place, it is sprayed with a solvent mixture, composed of a combination of volatile liquids with acetone as one of the active ingredients, which initiates setting and drying until it becomes rigid.

The vaporization of the solvent mixture leaves the bandage unchanged in its chemical composition, but the physical characteristics of the fabrication have been altered radically. The loosely knitted loops of yarn which previously gave great flexibility to the bandage now function as rigid strut members which serve to make the supporting medium an open-meshed but strong structure. In this state this medium

* The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official, or reflecting the views of the Navy Department or the naval service at large.

is mechanically efficient, very light in weight, resistant to moisture, non-resistant to *x*-rays and comfortable to the patient.

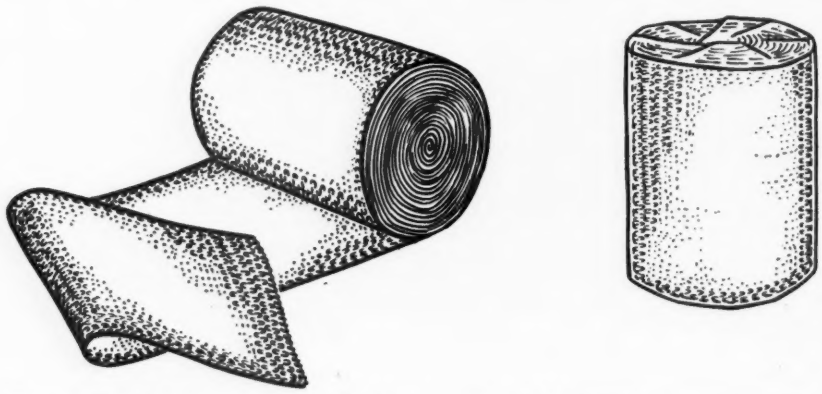


FIG. 1. Sketch of an unrolled Aire-Lite bandage (left) showing its open-mesh character; and (right) as it is supplied wrapped in cellophane.

We have applied Aire-Lite upon 136 patients, as indicated, in this hospital from March 27, 1944, to October 10, 1944, inclusive. One hundred twenty-two of these were in-patients and fourteen were out-patients. The vast majority of the former were of active service age, including two females, and all but two of these patients were ambulant. The out-patients were seven adult males, five adult females and a female and male child five and three years old, respectively.

Patients for Whom Aire-Lite Was Used (*Table* 1): We have classified the patients for whom Aire-Lite was utilized in this series as fractures and miscellaneous orthopedic conditions. There were eighty-six fractures of which simple and compound injuries were evenly divided. In twenty-two cases Aire-Lite was used as primary fixation at and subsequent to onset of treatment. Seventeen simple and one compound fracture thus treated were acute, four of which required manipulative reduction and fixation under anesthesia. The bones injured involved the hand in five instances, sternum in one, clavicle in one, ankle in three, shaft of the tibia and fibula in one, lower radius in three, head of the radius in one, carpal scaphoid in one and the body of the scapula in one.

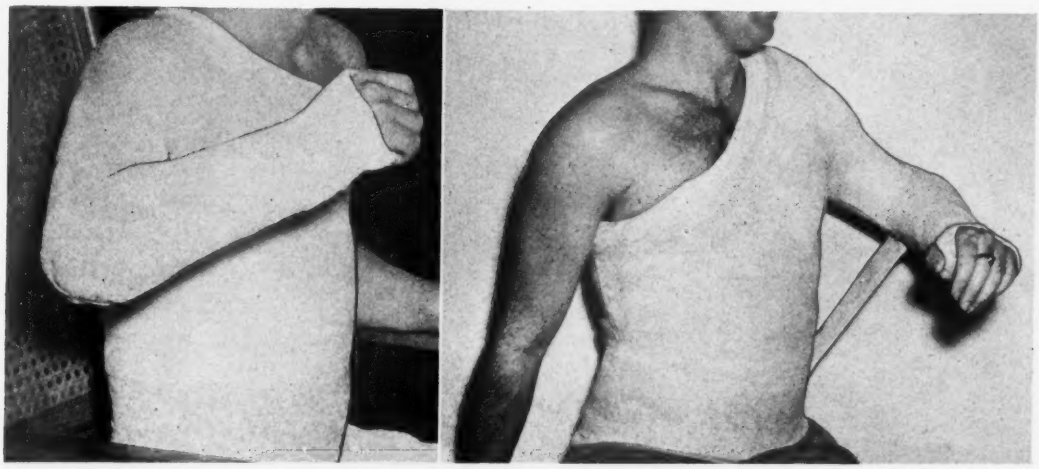
In sixty-four fractures Aire-Lite was used, subsequent to plaster or other methods of fixation which had been previously instituted, as an alternative (secondary fixation) apparatus. Twenty-two of these were simple fractures which had been present from several days with little or no callus formation to variable stages of convalescence when Aire-Lite fixation was employed. Ten simple fractures involved the small and irregular bones of the extremities and vertebral bodies, four the lower radius (Colles') and eight were of the long bones. Forty-two compound fractures were secondarily immobilized by Aire-Lite.

TABLE 1
CONDITIONS FOR WHICH AIRE-LITE WAS USED

	Primary Aire-Lite Fixation	Secondary Aire-Lite Fixation	Total number of Cases
I. Fractures:			
Simple	21	22	43
Compound	1	42	43
II. Miscellaneous Orthopedic Conditions:			
Diseases	8	4	12
Mechanical or static	18	10	28
Post-traumatic	9	1	10
Total	57	79	136

Primary, Aire-Lite fixation implies its initial employment from the onset of treatment as a substitute for plaster. *Secondary*, Aire-Lite fixation implies its use as an alternative apparatus, subsequent to the prior use of plaster or other forms of treatment.

Thirty-six of these were severe. The vast majority involved the long bones, and showed variable degrees of bony dissolution and osteomyelitis with little or no evidence of wound healing or bony regeneration at the time Aire-Lite fixation was begun.



A B

Fig. 2. Traditional types of Aire-Lite shoulder spicas. A, on a severe compound fracture of the upper humerus and scapula. Abduction of the arm was maintained intrinsically, without the incorporation of wooden struts between the elbow and body. B, on a tuberculous shoulder; three months after a combined intra- and extra-articular operative fusion had been done. A yucca wood strut has been incorporated between the elbow and body in this instance.

There were fifty miscellaneous orthopedic conditions which included: diseased, static or mechanical situations, congenital anomalies and post-traumatic conditions of the locomotor system other than fractures, for which immobilization was desirable. The pathological lesions included hemotogenous pyogenic osteomyelitis, tuberculosis, arthritis and osteochondritis. Among the static or mechanical conditions, idiopathic low back pain and internal derangement of the knee joint were prominent. There were also a group of residual deformities which were neurogenic, arthrogenic and myositic in origin. There was one case of bilateral congenital club foot in a male child. In contrast to the group of fracture cases, the vast majority of these miscellaneous cases were primarily fixed by Aire-Lite.

Aire-Lite Type Apparatus Applied (*Table* II): Two hundred Aire-Lite casts and various forms of orthopedic apparatus of the same material were made in this series. One hundred sixty-seven traditional casts were applied upon 115 patients. Eighty-seven patients wore one cast each and twenty-eight wore two or more successive casts each. Eighty-three casts were applied to the upper extremity. In fifteen instances the casts included the thumb and the proximal phalanges. Eight of the arm casts capped the shoulder. Nine shoulder spicas

Table II
AIRE-LITE APPARATUS APPLIED

Region of body immobilized	Type of Aire-Lite Fixation			Total number of Aire-Lite Apparatus
	Traditional Casts	Casts with Traction	Miscellaneous Apparatus	
Upper extremity:				
Forearm	35	9	12	56
Arm	41		1	42
Arm and shoulder	9		1	10
Spine	22			22
Lower extremity:				
Lower leg	32		4	36
Leg and thigh	25	1	5	31
Hip and lower extremity	3			
Total	167	10	23	200

were made (Fig. 2), of which seven were traditional in type and held the arm away from the body in varying degrees of abduction, while two secured the arm to the body. In one traditional shoulder spica a Cameron wire splint was incorporated in the cast to help support the arm. In the remaining six, three had yucca wood struts between the elbow and the body and three maintained abduction without additional aid. Twenty-two Aire-Lite casts supported the spine, two of which included the neck and occiput. (Minerva, Fig. 3.) In the other twenty body jackets, four went over the shoulders and sixteen ended at the axillae. In two instances the body jackets were reinforced by yucca wood splints, which were incorporated along the lumbar spine and along the sides.

FIG. 3. Minerva type of Aire-Lite cast on a case of post-traumatic arthritis of the cervical spine. The portion of the cast covering the larynx and ears may be fenestrated or left unsprayed with the cementing fluid, as desired.

Sixty casts were applied to include one or more components of the lower extremity. (Fig. 4.) Three hip spicas were made. Two of the three hip spica casts were worn by ambulatory patients. One was complete and reached to the toes; one extended to the ankle and the other to midway between the knee and ankle. Thirty-four casts were subjected to direct or indirect weight-bearing. Sixteen of these were endbearing on a rubber tipped aluminum button, secured by the plastic bandage in the usual manner. Six of twelve Aire-Lite casts which had been made for the child with congenital club foot, bore weight directly in the same way as did the previously applied plaster casts. There were twelve walking cylinders which extended from the ankle to the groin, respectively.

Ten complete plastic casts were applied to ten patients which sustained and maintained elastic or fixed traction. Nine of these casts extended from the knuckles to the elbow and had incorporated either a longitudinal or a banjo type of elastic traction. Five of these were exerted upon the skin and four on the bone by skeletal transfixion. There was one Aire-Lite cast which extended from the toes to the upper thigh into which a proximal and distal Steinmann pin through the tibia was incorporated and maintained

Twenty-three orthopedic Aire-Lite apparatus were utilized as indicated; partly for eleven additional patients, several of whom had more than one such element, and the remainder in addition to cast treatment above. The splints made were dorsal, volar, finger, and gutter types. There were four Delbet leg splints, two of which were applied over an Unna paste boot. Elastic corrective traction was devised for wrist and elbow deformities, the former by dividing the cast at the wrist and the latter through incorporated aluminum hinges at their respective centers of rotation. (Fig. 5.) A walking cylinder hinged at the knee was utilized in one case. Two thigh buckets for provisional artificial limbs were

fashioned and secured to revised Thomas splints.

Aire-Lite Technic. Our basic technique (Fig. 6) was predicated on the following inherent characteristics of the Aire-Lite bandage; reactive time lag between the bandage and the solvent as a cementing agent, slight tendency toward shrinkage and liability toward loss of its open mesh (porous) looped structure; which may be summarized as follows:

1. An unhurried attitude and technic is essential. Work calmly and deliberately; handle the bandages gently but perseveringly.

2. *Do not stretch or pull the bandage into place* because such tension will result in undue subsequent shrinkage when setting and drying has occurred. In order to go around prominent curves, pleat, fold or cut partially or completely at that point and begin another section properly overlapped and directed.

3. *Do not mold or handle the wetted bandage as prescribed for plaster,* because this will cause subsequent gelatinization and loss of porosity when the bandage has hardened. Instead, continue with smooth gentle pressure and stroking efforts toward their adherence, taking care to secure overlapping edges which do require additional cementing fluid.

The bandage itself can be applied in one or all of the following ways as desired in the individual case (Fig. 6):

1. *Stockinette.* In this form a suitable length of bandage is cut and rolled upon itself to form the typical "doughnut" which is then unrolled on the extremity to be fixed. Such applications are effective as initial, intermediate, and finishing layers upon the extremities. Small casts may be built up entirely by successive layers applied in this manner.

Fig. 4. Long leg Aire-Lite cast on a simple fracture of the tibia and fibula, extending from the toes to the upper thigh, which was made by the combined stockinette, splint and roller bandage technic.

2. *Splint.* In this form the bandage is utilized in convenient lengths and width. In general, splints are applied, wetted and secured one at a time. This form is particularly useful to reinforce joints and other areas which are, or may be, subjected to localized stresses. Splint technic is useful in the treatment of Colles' fractures. They are thus applied while traction and countertraction is maintained. Splints may be arranged and affixed as follows: longitudinally, hair-pin, diagonally, crossed, staggered, or figure-of-eight. Splints are adhered or bonded best by securing one end first and then by following through in lengths of about twelve inches at a time.

3. *Roller Bandage.* This form is universally applicable to all parts of the body, and is rolled as one would a roller gauze bandage. For the average cast we recommend an equivalent of three complete thicknesses of the bandage throughout and reinforced by judiciously placed splints. *Care must be taken to overlap succeeding turns of the bandage slightly more than halfway in order to preclude weaker areas containing only one layer of the material.*

COMMENTS

A modern medium of clinical immobilization must meet and satisfy one or more

or all of several definite indications for its use in designated surgical and orthopedic cases. The greatest demand thus made upon the apparatus is for absolute clinical immobilization as in the treatment of fractures. Furthermore, there are requirements in which the mechanical quality of apparatus functions indirectly or relatively as follows: to stilt or splint, sustain and traction or maintain fixed traction, and correct deformity. (Figs. 7 and 8.)

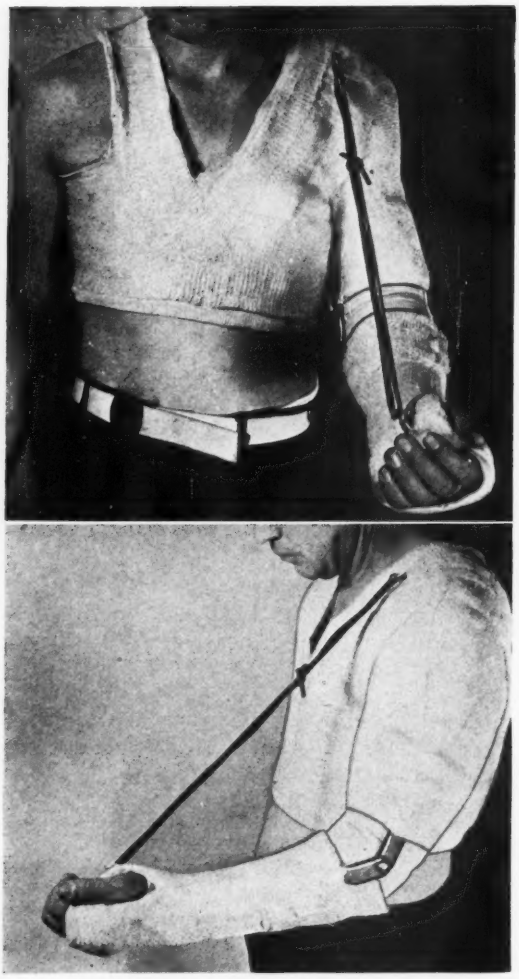


FIG. 5. A and B, front and side views of an Aire-Lite modified shoulder spica on a post-traumatic extension contracture of the left elbow, which was at about 180 degrees at the time this apparatus was applied. Fifty degrees of correction were obtained by gradual elastic (rubber tubing) bowstring force exerted through the incorporated hinges at the elbow joint. When this limit was reached, further correction to 80 degrees was accomplished by operative lengthening of the triceps tendon and posterior capsulotomy.

The therapeutic individualization of Aire-Lite has been summarized in Tables I and II. The preponderant use of Aire-Lite as an alternative apparatus (secondary) in the treatment of fractures was due at first to an understandable caution arising from working with a new medium, in part to the longer period of time it takes for setting and drying, and also because most of our fracture patients were evacuees from combat areas who had been treated previously by plaster or skeletal fixation. As confidence with the new plastic method and opportunity developed, a number of acute fractures were selected for clinical trial with Aire-Lite immobilization. These were successfully immobilized by this means. However, the vast majority of the simple fractures primarily thus treated by Aire-Lite did not require manipulative reduction because there was little or no displacement. These patients were not anesthetized and were thereby co-operative to a degree which compensated for the additional time and patience required by this method. Acute fractures of the small bones, Colles' fractures and fractures without displacement are, therefore, amenable to primary Aire-Lite plastic fixation. The progress of two of four fractures which were primarily treated by reduction and fixation under general anesthesia was satisfactory. Two fractures which could not be reduced by closed methods required operation. In the first of these a new plastic cast was applied postoperatively. In the second, the original cast was split dorsally, removed, and successfully reapplied after operation because of the characteristic resilience of this type of cast. (Fig. 9.) Those fractures primarily treated by Aire-Lite, which remained under our observation, healed in the normal manner.

The alternative (secondary) employment of Aire-Lite in the convalescent stages of both simple and compound fractures was both practicable and desirable in the former and was usually preferable to plaster in the latter. One of the earliest cases in our series presented a severe com-

pound fracture, with infection, sciatic nerve avulsion, and loss of bony substance, of the upper third of the femur. A similar case involved the mid-tibia and fibula. Some bony regeneration was present in the femoral lesion but none in the other when the plastic was employed. A complete plastic hip spica was applied in the former under traction and pentothal sodium anesthesia. In the second case (Fig. 10), the pins which had been previously fixed in plaster were subsequently incorporated in the Aire-Lite cast. A course of penicillin therapy and surgical revision was indicated in this case because of a persistent gas bacillus infection, and was

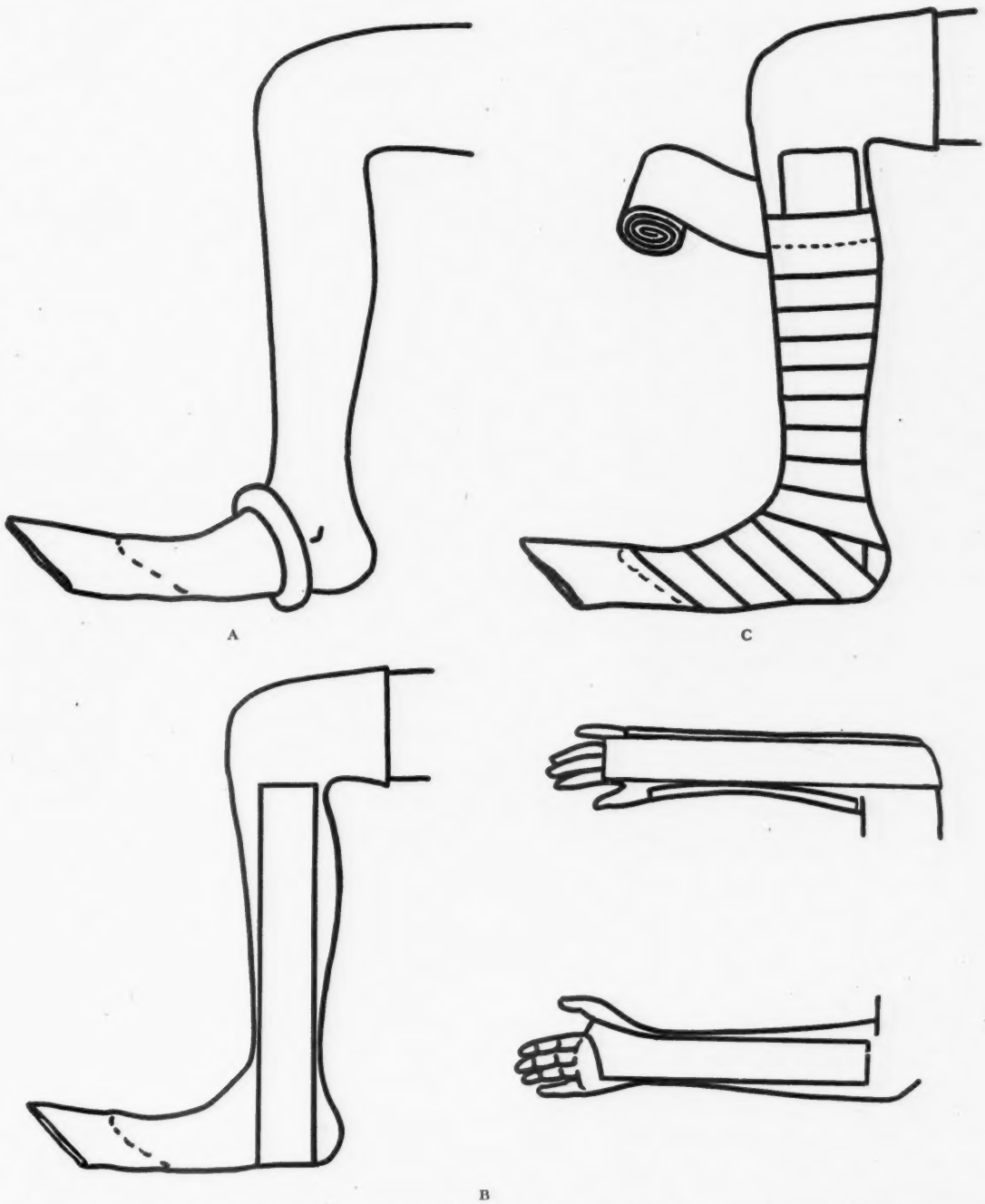


Fig. 6. Drawings illustrating the basic technic of applying Aire-Lite: (A) stockinette, (B) splint, and (C) roller bandage.

conveniently performed through a window in the plastic cast. The postoperative convalescence was excellent, and no additional proved of great value in the vast majority of the compound fractures since they were complicated by drainage. The Orr method

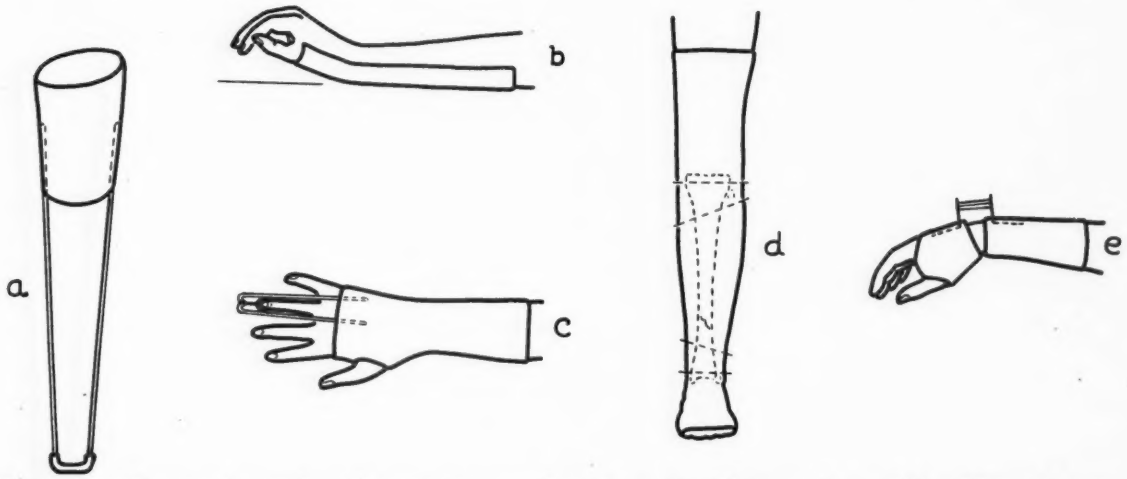
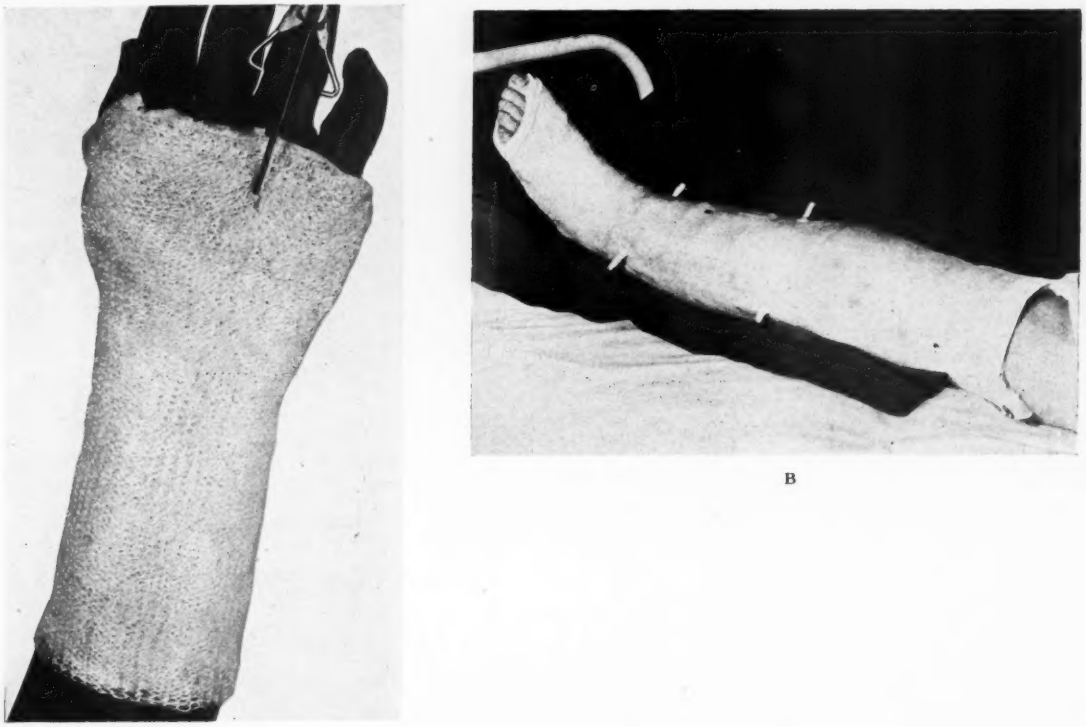


FIG. 7. Aire-Lite may be used to advantage in a number of ways in addition to the traditional forms of casts: (*a*) As a bucket for provisional artificial limbs; (*b*) as a cock-up splint, or other type of splint; (*c*) to sustain end traction; (*d*) to maintain fixed skeletal traction; and (*e*) to correct deformity, in this instance a flexion contracture of the wrist by dorsal elastic traction.



A B

FIG. 8. Aire-Lite casts showing: A, on a simple fracture of the fourth metacarpal head, treated by skeletal traction; B, on a severe compound fracture of the tibia and fibula (complicated by Bacillus Welchii), treated by fixed skeletal traction.

definitive surgical treatment was necessary at that time.

The resistance to moisture of Aire-Lite was used in a number of those in which surgical revisions were indicated. Plaster was applied immediately after operation

in order to save operating room time. When the plaster became soggy in a week or two it was removed and an Aire-Lite cast was

Fig. 9. Two Aire-Lite casts which had been previously applied upon a case of bilateral congenital club foot, following their removal, showing the characteristic resilience of Aire-Lite. The casts sprang back and maintained their original form after removal.

then substituted. These Aire-Lite casts remained until healing was complete because they were unaffected by the drainage. Among these cases there were eight infected compound fractures which were operated upon and also given a course of intramuscular and local penicillin through a window in the Aire-Lite cast. (Fig. 11.) The almost complete absence of malodor in those instances was noteworthy, and sound healing occurred in from four to ten weeks.

A method of clinical fixation which aspires to be universally applicable must also possess certain inherent mechanical prerequisites and demonstrate additional functional requisites, none of which can be properly subordinated to the others, as follows: (1) It should be well tolerated by and acceptable to the patient. (2) It must possess both mechanical efficiency and adaptability to the body contours. (3) It ought to be technically feasible for surgeons in general.

More than one-half of the patients immobilized by Aire-Lite in this series had previously worn plaster casts. Their spontaneous favorable reactions to Aire-Lite apparatus gave impetus to improved technics and a more inclusive employment of this medium. The same reaction was observed among those patients who were primarily treated by this method. All patients were quick to appreciate the lightness, ventilation, and other hygienic advantages of Aire-Lite, which permitted them to bathe or shower in the normal manner.

The mechanical efficiency and anatomical adaptability of this plastic medium of support was adequate in the vast majority of our cases. There were practically no mechanical deficiencies noted because of inherent defects of the plastic material itself. Breakage occurred in eight casts because of faulty technic or uncontrollable external violence as follows: Transversely

across the anterior border of the elbow in one case, the volar part of the wrist in one, anterior border of the knee in two, tendon

FIG. 10. *X*-ray of a severe compound infected fracture of the tibia and fibula taken through an Aire-Lite cast. There has been practically no resistance to the *x*-rays by the Aire-Lite, and the sequestrums are notable. (Same case as Fig. 8B.)

achilles in two, posterior mid-leg in one, and at the groin in a hip spica some eight weeks after it had been applied on an ambulant patient. There were no unhappy consequences to patients as a result of these accidents. In six cases breakage occurred at a point which was composed of only one layer of the bandage. In two instances it was due to uncontrollable accidental violence. The remarkable strength of an Aire-Lite cast which had been unintentionally oversaturated with the cementing fluid was illustrated by an end-bearing fenestrated cast which extended from the toes to the upper thigh. The patient had worn this cast for ten weeks when he accidentally fell from a height of about fifteen feet without injuring himself or the plastic cast.

The strength of an Aire-Lite cast can

FIG. 11. Showing a fenestrated Aire-Lite cast on an infected compound fracture of the tibia after sequestrectomy, by the Orr method, combined with intramuscular injections and local instillations of penicillin. Vaseline gauze protects the margins of the wound. The gauze pack has been removed to show the appearance of the wound about one week after operation. The rapidity of healing and minimal malodor in the patients thus treated were remarkable.

be essentially controlled by observing proper technic, particularly that relative to adequate thickness and bonding. Cellulose acetate, as calibrated in industry, has a high "impact strength, or resistance to breakage under sudden, hard blows. Pieces may be cemented together to make a bond as strong as the material itself. Hardness can be varied within limits, but in general, it is comparable with that of hard rubber, aluminum or hard oak wood."

A serious drawback to Aire-Lite, as was observed by us, was shrinkage. This usually occurred to a slight degree soon after it became rigid and usually reached its maximum twelve to twenty-four hours afterward. There were no untoward clinical consequences because of this shrinkage; but several Aire-Lite casts had to be removed and new ones reapplied because of painful constrictions. Shrinkage manifests itself clinically by constriction (circumferential) and creepage (longitudinal retraction). The former was especially notable about the knuckles and web of the thumb, over bony prominences in general and the female breast. This can be obviated by careful application, padding, spraying and trimming in these areas. The latter became manifest especially in body jackets and over the thighs, and here, too, special

care must be observed to avoid such untoward results.

Plastic casts, splints, etc., can be made to conform to all parts of the body. The highly specialized dynamic function and proneness toward neurocirculatory disturbances of the hand and forearm makes exacting demands upon both surgeon and supporting medium here. The relative small size and absence of weight bearing, however, makes it easier to begin with the Aire-Lite method in this situation. Premature attempts to reproduce the more extensive apparatus we have mentioned should not be undertaken until one has become familiar with the technic. Body jackets, however, (Fig. 12) become increasingly attractive with practice.

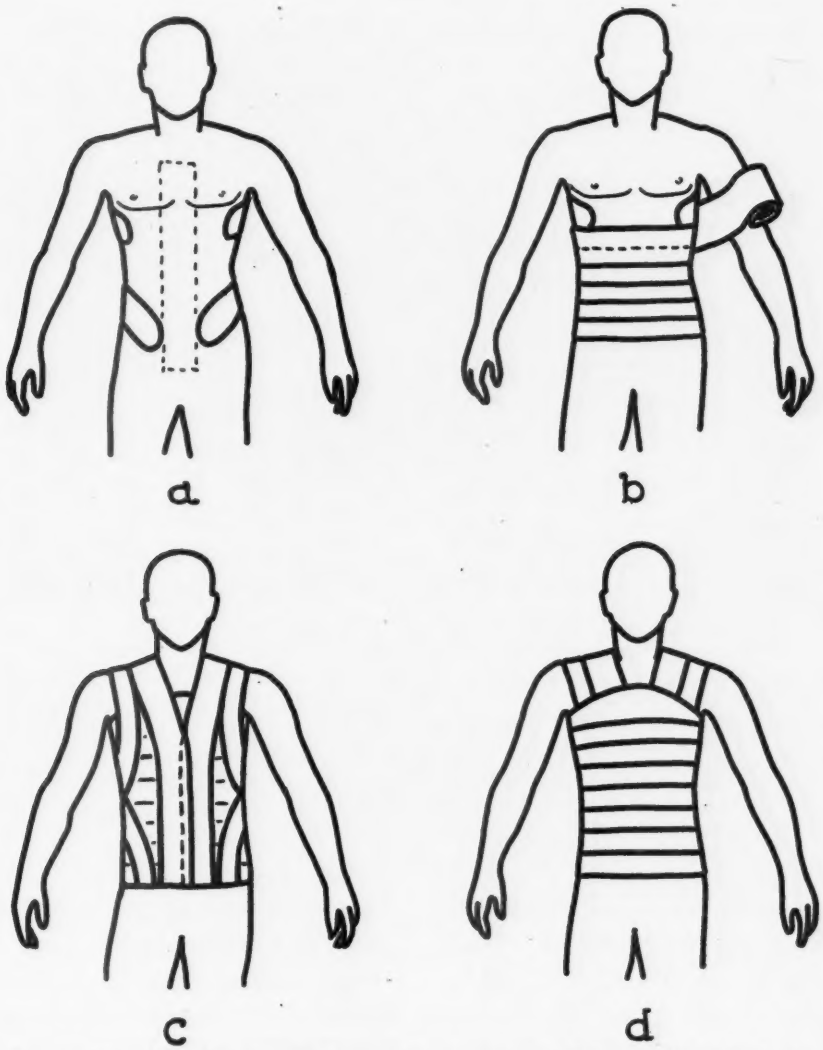


Fig. 12. Drawings showing the successive stages in applying an Aire-Lite body jacket: (*a*) Thin felt pads are placed as shown over a double layer of orthopedic stockinette. (The latter has been omitted in the drawing.) (*b*) A circular layer of Aire-Lite is then wrapped on from below upward to the axillae. (*c*) Reinforcing splints are run over the shoulder and cross below the axillae in all cases, whether or not the finished cast will include the shoulders. Additional plastic splints or yucca wood may be placed along the spine and at the sides if desired. (*d*) The cast is finished by two or more additional circular wrappings of the Aire-Lite bandage.

Aire-Lite technic is simple but exacting. The skin is cleansed and dried in the usual manner, and is followed by one or two layers of orthopedic stockinette as desired.

Except in recumbent patients, no further padding is required, *provided one has become thoroughly proficient with the method.*

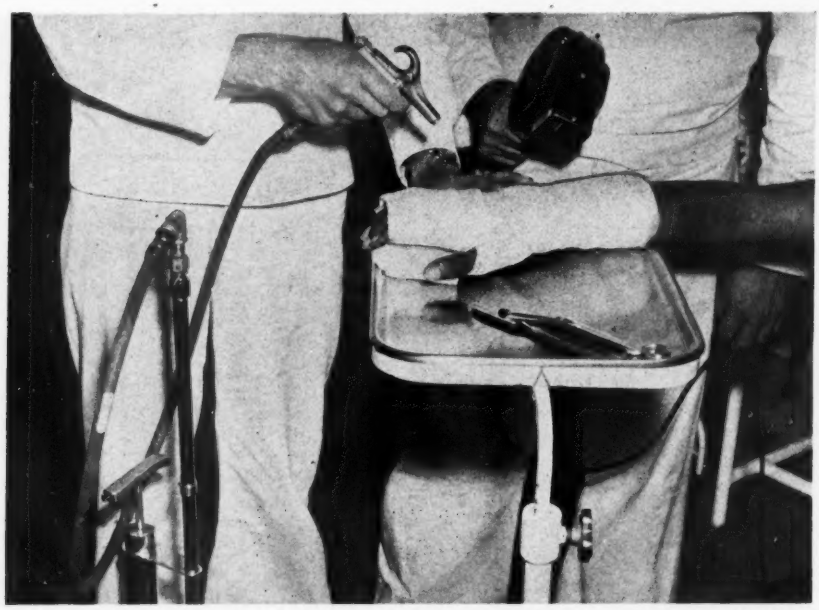


FIG. 13. Photograph showing the two pieces of auxiliary equipment which are used, *not simultaneously*, in the application of Aire-Lite apparatus: an ordinary forced draft hair dryer and the spraying apparatus. The latter consists essentially of a compact and portable unit comprising a pressure reservoir (which is not shown here), a manually operated air pump, and a pressure spray gun attached to the reservoir by means of a flexible tube. Construction is such as to provide an adequate air reservoir above the liquid which is pumped to a gauge pressure of approximately twenty-five pounds per square inch, thus providing a spray of liquid without continuous pumping.

The beginner, should observe the usual precautions along this line. Start and end the material beyond the delineated limits of support in order to anticipate creepage and to facilitate final revision for neatness and comfort. The cementing fluid is sprayed on at a right angle to each complete layer of the bandage and as needed to secure proximal and distal ends of the bandage. (Fig. 13.) This should be repeated just before applying each successive layer to facilitate adherence and bonding. Oversaturation of the yarn, especially at dependent portions, causes gumminess, subsequent gelatinization and loss of open mesh structure. Insufficient wetting results in a yielding and blistered (non-adherent) surface structure.

The setting and drying characteristics of Aire-Lite differ from plaster. The initial contact between an optimum dry bandage (cellulose acetate is slightly hygroscopic) and the liquid spray is accompanied by a scarcely audible fine hissing and crepitating sound. Immediately afterward, the mesh glistens with superficial moisture, but has not yet lost its slight starchy consistency. In a few seconds it becomes formable. This is followed by drying and setting. *The last event takes longer spontaneously than plaster.* Setting of Aire-Lite is, therefore, hastened by the use of a forced draft of hot air while the wetted bandage is being shaped immediately after it has softened; or one can complete the cast and place it within a pillow case into which the hot air is directed. *The hot air and spray should not be used simultaneously.*

The rigid state of Aire-Lite can be softened if desired by the application of pure acetone or other good solvent. Once again, when the solvent has evaporated, the rigid state is resumed. *It should be remembered in this connection that some degree of softening occurs each time the solvent has been*

sprayed on during the application of an Aire-Lite cast. The maintenance of proper position and avoidance of hand-hold indention and other distortions on the finished product is therefore obligatory on the surgeon.

Aire-Lite can be applied in any ventilated room, office or hospital practice. The fumes from the evaporating cementing fluid were disagreeable to some patients when exposed to it for considerable periods. Smoking should not be permitted where this method is in progress. The plastic material burns "reluctantly." Sensitive skins of operators may become excessively dry from the effect of the cementing fluid. The use of rubber gloves or a light application of mineral oil gives adequate protection. The skin flakes left on the hands are easily removed by rinsing the hands in warm water.

CONCLUSIONS

"Aire-Lite," a new and effective plastic medium of clinical immobilization, has been introduced. This preliminary report is based on a series of 136 patients upon whom 200 plastic casts and miscellaneous apparatus made of the same material were employed.

Users of Aire-Lite, in its present state of development, should not expect it to replace plaster. The use of Aire-Lite fixation in acute fractures, except as mentioned in the discussion, is not wholly practicable because of the time element involved, but remains optional with the desire and discretion of the individual surgeon. Aire-Lite can be used effectively instead of plaster (primarily) in a wide variety of orthopedic conditions as a cast, splint or other form of apparatus. The same alternative use of Aire-Lite fixation in the convalescent stages of both simple and compound fractures has also been established.

A word of caution is in order at this point: Since Aire-Lite is a synthetic plastic product, atmospheric conditions, etc., may influence its behavior in practice and interfere with uniformity of its setting and drying characteristics. One aspect of this phase of the problem is the variable tendency it has toward shrinkage and creepage which must be anticipated and guarded against by observing a proper technic and keeping the patient under observation, especially for the first twenty-four hours after a cast has been applied.

The light weight, ventilation, resistance to moisture, non-resistance to *x*-ray, general tidiness attending its use and acceptability to the patient gives Aire-Lite a distinct advantage over plaster.

The greatest drawback to Aire-Lite from the standpoint of the surgeon who has become accustomed to plaster is the longer period of time it takes to set and become rigid. Improved methods of fabrication and technic are needed to remedy this disadvantage.

The advantages of Aire-Lite, accruing from its inherent resistance to moisture, under naval and similar sea-going conditions, are noted. No less important is the factor of Aire-Lite's light weight from the angle of air transport.

PROCIDENTIA

THE CHAFFIN VAGINAL SUBTOTAL HYSTERECTOMY FOR THE CURE OF FOURTH DEGREE PROLAPSE—REVIEW OF TECHNIC AND RESULTS

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LOS ANGELES, CALIFORNIA

IN 1919, I published an article on a vaginal plastic procedure, which proved of value in correcting certain types of birth canal injuries, known as the Watkins-Wertheim operation. The operation, like all new methods, had to stand the test of time and skill, of the experienced as well as the inexperienced technician.

I have been performing this operation since 1912, and first reported it in 1919.[1] At that time it was a new procedure; its indications and its limitations had to be determined. Because these limitations were not known, too much was expected, and since the operation failed to cure every degree of prolapse, it was abandoned much too early and did not retain many enthusiastic followers.

But for those surgeons who had courage and more than average interest in vaginal reconstructive surgery, it has proved to be a very valuable constructive operation and many believe, as I do, that when indicated, as for instance in cases of cystocele of any degree, with first or second degree uterine descensus, the interposition operation is superior to every other kind of vaginal plastic procedure.

In my opinion, it is the most successful treatment of cystocele, because it is the only one that completely obliterates the opening through which the bladder protrudes. (Figs. 1 and 2.)

All types of abdominal suspension usually fail in some respects, whether they be round ligament suspension or abdominal fixation. Neither one deals with the problem of restoring the 90° angle, and restoring the sacrocervical "pull." Nor do they place a support beneath the bladder and a floor to resist the intra-abdominal pressure. Many vaginal plastic operations have been devised for the treatment of cystocele, including the old and probably obsolete anterior colporrhaphy—an eliptical excision of anterior vaginal wall—which adds nothing to the impaired support. The anterior wall fascia is so thin that when once torn, it cannot be satisfactorily identified and returned for adequate support.[2]

The advancement operation, performed by loosening and displacing the bladder upward on the anterior wall of the uterus, thus suturing the vagina to anterior uterus and cervix, is easy and simple to perform. But it can be regarded as a satisfactory method only in cases of moderate cystocele.[3]

For the past few years, much has been written on a revised procedure of this operation, generally described by the name of "Manchester" operation. It is not mentioned under that name in many of the textbooks of gynecology. The reason may be that it is not a standardized plan but a modification of several other operations, namely, anterior colporrhaphy, bladder advancement and cervix amputation. Whether by this operation cases of cystocele can be remedied depends entirely on the ability of retrieving some semblance of the anterior vaginal wall fascia, uniting or plicating its median. Only in rare cases can that fascia be identified on both sides; therefore, what is often done is an elliptical or quadrangular resection of anterior vaginal wall and narrowing by sutures, resulting in an unfolding of the bladder and providing a support no stronger than the tensile strength of the vaginal wall, a tissue of practically unlimited elasticity.

This surgery supplies no new support and does not replace destroyed tissue with a substitute. It cannot prevent the uterine descensus, because it does not take into consideration the structures supporting the corpus. An attempt may be made to draw the lower edge of the broad ligaments out anteriorly to the cervix, but these tissues have little tensile strength. The fact that most, if not all, operators finish by amputating the cervix, must be regarded as an admission of not having corrected the uterine descensus. Therefore, they cut off the protruding portion in order to save embarrassment.

Fig. 1. Sectional view of interposition operation shows the anterior (cystocele) space to be completely closed by the fundus.

The bladder is the chief symptom-producing factor in this complex. And in providing support to the bladder, the Watkins-Wertheim operation is vastly superior to the Manchester procedure. But it should be emphasized that the Watkins-Wertheim operation applies only to the first or second degree descensus. It is much easier to perform than the Manchester operation. I have completed many operations of this kind in fifteen or twenty minutes, and cannot recall ever having taken more than thirty minutes, unless the case was complicated by fibroids, chronic pelvic inflammatory disease, or other pathological condition. My own technic of the Watkins-Wertheim operation may vary slightly from that of other surgeons in that I loosen the vaginal wall and bladder well laterally, probably somewhat more so than many other operators.

But neither the Manchester nor the Watkins-Wertheim operation will remedy the fourth or fifth degree of prolapse, and they should not be attempted in such cases, the reason being that neither supplies a substitute for the sacrocervical (textbooks use the term sacro-uterine) ligaments and without this support the uterus will not remain in an axis of a degree approaching 90°, therefore a protruding cervix.

Total Vaginal Hysterectomy (Not Recommended). I do not consider the total vagi-

nal hysterectomy a constructive or scientific treatment of the prolapsed uterus. Many years ago Palmer[4] and others stated that

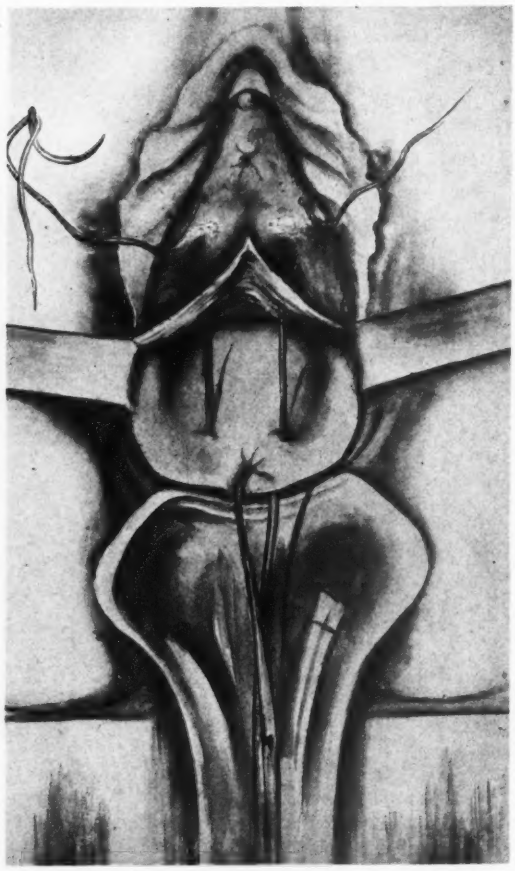

FIG. 2. Placing of the anchor sutures (should be two) well out nearly to pubic periosteum in pubovaginal fascia anchors the corpus beneath the urethra. The same with the cervix in our operation.

the indications for vaginal hysterectomy were those for "removal of a diseased uterus," and not a protruding one. I concur in this statement, but I do not consider a cystic or eroded cervix to be a diseased uterus. Total hysterectomy is not indicated in such a case, as one-half to one minute Percy cautery application will remedy this minor condition. (Fig. 3.) In my own practice I have found it necessary to perform total vaginal hysterectomy only twice in the past fifteen years. In both cases the uterus was badly diseased: One operation was for a long, protruding uterus with ulceration and cellulitis of the cervix, and the other for a long, protruding uterus with beginning epithelioma of the cervix.

Total vaginal hysterectomy is technically not difficult to perform, that is the removal of the uterus itself, but as the total removal of the uterus leaves only the broad and round ligaments and overstretched thin sacrocervical ligaments with which to make repair, they must either be sutured anterior to support the bladder, permitting the possible sagging of the cul-de-sac, or if anchored posterior to this structure, the bladder may protrude. *Our operation furnishes separate support for these structures.* (Fig. 4.)

In 1937, I described an operation especially devised to remedy the fourth degree prolapse, with uterus, bladder and cul-de-sac protrusion (so-called cul-de-sac or vaginal hernia). It is now generally known as the "Chaffin Vaginal Subtotal" hysterectomy for prolapse.[5] It is based on sound mechanical principles, and attempts to avoid as far as possible any unnecessary alteration of the physiology or anatomy of the patient. At time of publication, only a limited number of patients had been operated upon by this method and the results were uniformly excellent. Yet, sufficient time had not elapsed to determine the possibility of recurrence. Now after approximately fifteen years have elapsed a check of something over seventy-five cases about equally divided between clinic and private, no recurrences were found. The clinic cases could not be completely followed, so there may have been recurrences there, but the percentage would be extremely low, probably not more than 1 to 2 per cent, and as that percentage seems to be much lower than some others reporting (Counseller,[7] Masson,[8] Phaneuf,[9] and others), I believe I am justified in again calling my readers' attention to the operation and will attempt to explain the extreme simplicity of the technic in anticipation of others adopting it as a safer, easier and more satisfactory procedure than some of those generally done.

MECHANICS OF PROLAPSE

The round and broad ligaments are inadequate to stand the strain of holding the

fundus in place. They are overstretched, allowing the fundus to fall backward. The pelvic floor is damaged. The levatore muscles are separated and the outlet recedes toward the coccyx. This causes the axis of the uterus and the axis of the vagina to become parallel and thus all the necessary factors for a uterine descensus are present.

Only the so-called "sacro-uterine ligaments" would be able to prevent such a descent; but as they are hardly more than folds of peritoneum, their strength is insufficient.

The uterus is soon protruding. With it comes the bladder, because the intra-abdominal pressure is now greatest in the anterior space. Last, and fortunately less frequently, come the cul-de-sac tissues, posterior vaginal wall and rectum, completing the picture of a fourth degree procidentia with vaginal hernia.

Fig. 3. Preliminary application of cautery to external os and canal to "clean up" any eroded or cystic cervix. No other cautery has sufficient heat to do this.

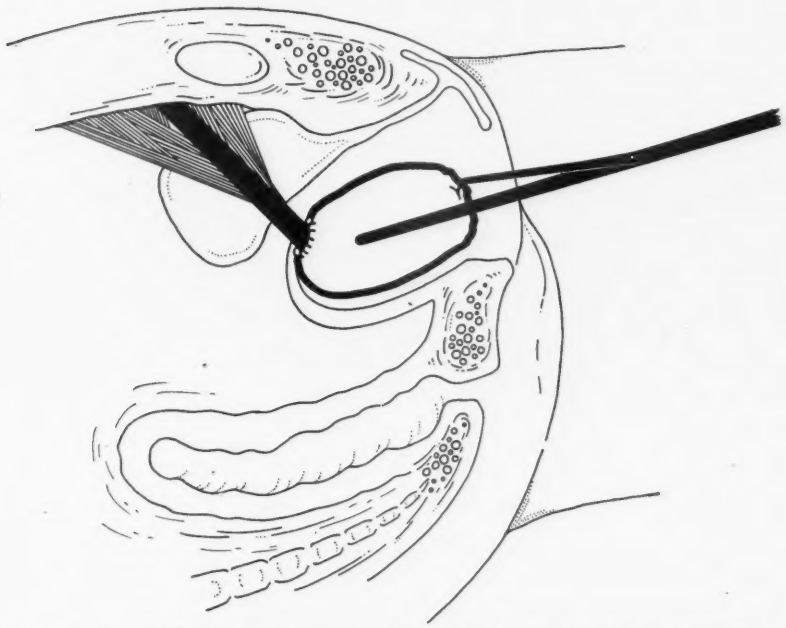

Fig. 4. Round ligaments, (sacrocervical substitution) anchored into the posterior cervix or cul-de-sac, hold the cervix well back.

PROBLEMS IN COMPLETE PROLAPSE

1. The bladder must be supported.
2. The vaginal canal must (or should) be preserved.
3. The vaginal vault or vaginal cul-de-sac must be held up.
4. The perineum (levatores between vagina and rectum) must be adequately restored to prevent anal prolapse, and

fecal mass from bulging into vagina, and restores the normal vaginal axis.

5. It is desirable to maintain vaginal moisture from normal cervical secretion.

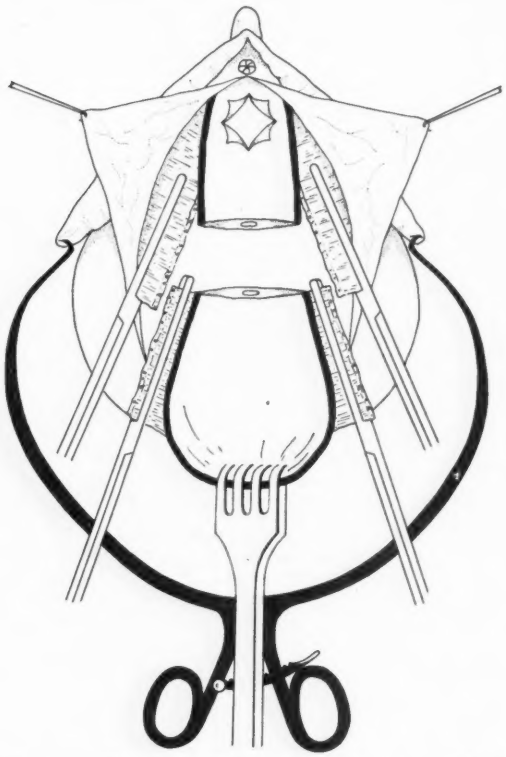

Fig. 5. Graphic illustration of the vaginal removal of the corpus to make ligaments available.

For the sake of clarity and understanding, the treatment may be divided into three factors: (1) bladder, (2) uterus, and (3) vaginal cul-de-sac.

Most of the patient's complaints are centered around the bladder, and they usually are: (1) retention, (2) protrusion, (3) frequency, and (4) leaking. The first two are the result of fascial support being removed from underneath, allowing the bladder to drop, or slide, along with the uterus or even entirely independent of the uterus.

The frequency is due to residual product. When the patient is in a sitting position, a portion of the bladder is on a lower level than the neck. Therefore, it does not completely empty, resulting in an irritable or infected bladder.

THEORY OF LEAKING

In the bladder neck is a muscle with sphincter action. The forces applying in a sphincter are centripetal: equal from all points of the circumference toward the center, and thereby forming a circle. But in order to be efficient the perfect circle must be preserved. The bladder neck at the first perforation of the pelvic diaphragm lies near the tendinous attachment of the levatores to the pubis. A full bladder without support pulls on this one remaining fixed point, and stretches the sphincter "out of round" or "oblong." This is the reason for leaking.

I cannot recall or find in the case records a single instance of leaking that was not remedied by either the Watkins-Wertheim or the Chaffin operation for prolapse, unless there are present intravesical disease, neurological impairment or actual neck damage.[10]

THE REMEDY

In discussing the technic of the "Chaffin Subtotal" operation for prolapse I will remind my readers again of the principles and accomplishment of the Watkins-Wertheim operation. It anchors the corpus to the pubovaginal fascia, completely closing the anterior space to everything but the urethra, therefore an absolute cure for cystocele. (Figs. 1 and 2.) But we have not dealt with the prolapsed cervix and cul-de-sac. The sacrocervical "pull" *must* be restored, but these ligaments are beyond redemption. Here we have in our operation a *substitution*. (Fig. 4.) After treating the cervix with the Percy cautery if indicated (Fig. 3), we remove the corpus (Fig. 5) through the anterior space, at or above the internal os, again applying the Percy cautery (Fig. 6) from above to the remaining cervix to destroy all endocervical mucous membrane. By removing the corpus we make the broad and round ligaments available.

We have learned that the anchoring of the fundus in the Watkins-Wertheim op-

eration will support the bladder, and just to the same degree will the suturing of the closed cervix (at site of amputation of corpus) to the pubovaginal fascia support the bladder. (Fig. 7.) Knowing these facts we now remove the corpus (Figs. 4 and 5) to make the round ligaments available, and utilize the broad and round ligaments by suturing them into the lower posterior surface of the cervix, or in the cul-de-sac hernia cases suture them into the cul-de-sac itself. At times in exaggerated cases we bring the ends of the ligaments through the cul-de-sac permitting the ends to protrude into the vagina. These ligaments now assume the rôle of the sacrocervical ligaments, that is, pull the cervix back and up. We agree that the direction of pull is different, but the results have proved this unimportant. In cases of large redundant posterior vaginal (cul-de-sac) tissue, some of the excess may be resected by a circular or quadrangular excision, the opening closed by appropriate suturing and with the same suture, anchor the broad ligament into the closure. Also in this type of case, there may be an extra long cervix, and if so, an amputation may be made. At the time of resecting the cul-de-sac redundancy and amputating the cervix the closing sutures may include the posterior lip of the amputated cervix through the opening. The anchoring of the closed upper end of the cervix to the pubovaginal fascia with two "interposition" sutures, and closing of the inverted "T" incision completes the operation. (Figs. 4 and 7.)

Occasionally, we see a patient with pelvic disease in addition to cystocele and prolapse. This pelvic disorder may be salpingitis, ovarian tumor, or large fibromyomas. These are the cases that if dealt with in the usual manner—a laparotomy for the pathological condition—as subtotal hysterectomy, the patient still has her cystocele and it is then a very difficult problem with which to deal. We handle

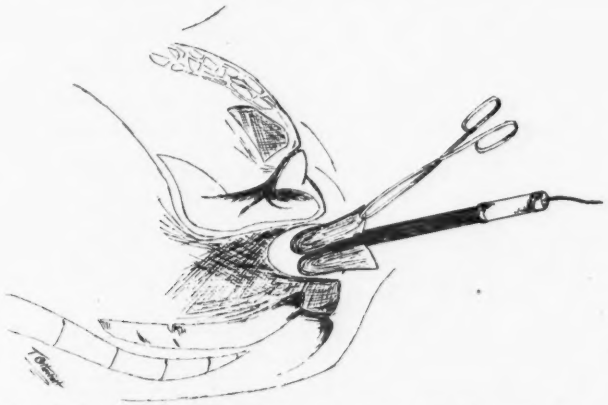

Fig. 6. Percy cautery applied to the cervix via internal os to destroy menstruating epithelium.

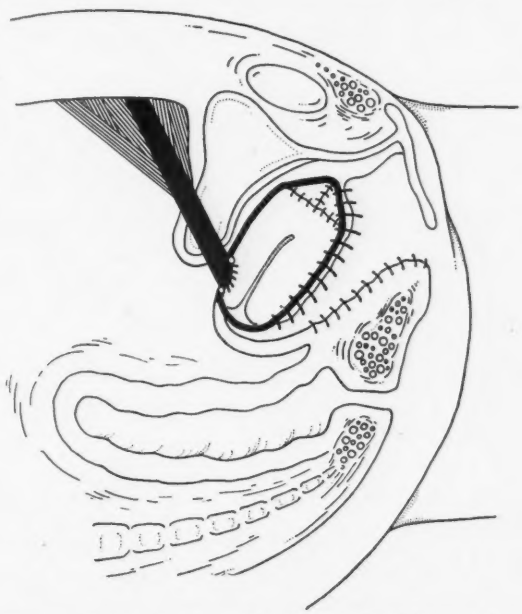

Fig. 7. Operation completed. Interposition anchor sutures holding the upper end of the cervix beneath urethra and the round ligaments holding the lower end of the cervix back, replacing the sacrocervical function.

this problem by removing via the abdomen the tumor, tubes and corpus, as indicated. But from this point my readers will please

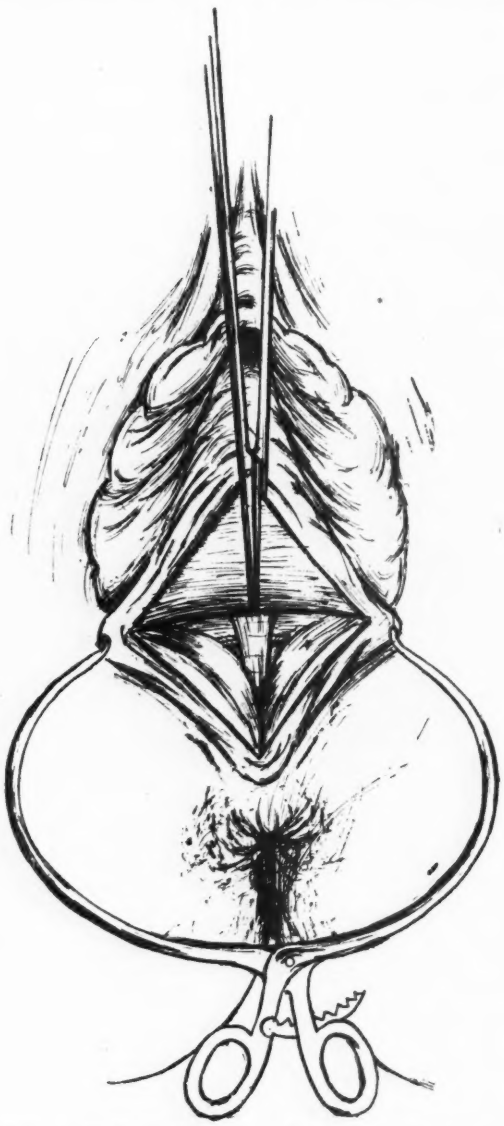

FIG. 8. Perineorrhaphy technic. Place Oschner forceps on "v" flap and it will not tear during mobilization. It is also a guide to symmetrical resection of "v" later. Levator muscles must be visualized.

note that after removing the corpus and closing the cervix the round ligaments must be sutured to the lower posterior cervix as in the vaginal operation. (Fig. 13.) Leave the cervix free and mobile, but cover with bladder flap. (Fig. 14.) Now close the abdomen and proceed with the vaginal surgery. Dissect the bladder from the cervix at the attachment of the cysto-cervical ligament and carry the dissection up till it meets with the dissection made above. Next draw out the upper end of the closed cervix and place the "interposition" sutures just as described in the Watkins-Wertheim and the Chaffin operation. Finish with perineorrhaphy.

What we have really done is the Chaffin operation by doing half from above and half from below, made necessary because of the pelvic disorder that had to be dealt with from above.

THE ACCOMPLISHMENT

1. The bladder is well up in the abdomen.
2. The cervix is anchored beneath the urethra.
3. The cervix and cul-de-sac are held up by the new substitution of the broad and round ligaments for the sacro-uterine (sacrocervical).
4. The vagina has normal length (depth).
5. The vagina has cervical secretion and the cervix is safe from cancer by double use of the Percy cautery.

Complete restoration of the levatore muscle function and reconstruction of the perineal body completes the operation. (Figs. 8, 9, 10, 11, and 12.)

In compliance with the request of many surgeons I have prepared a step-by-step description of the technic of the Chaffin operation for prolapse. Interns and residents with limited experience in vaginal surgery, have, by studying the notes, performed this operation in a creditable manner in their first attempt.

STEP TECHNIC FOR THE CHAFFIN OPERATION FOR THE CURE OF PROCIDENTIA

1. *Position:* Lithotomy, anus covered with towels clipped to posterior forchett. *Equipment:* Low Mayo table for instruments, two stools, surgeon and assistant. *Special Instruments:* Cat's paw (rake) retractors, Sim's retractor and tenaculum sound (tenaculum sound is most needed of all instruments), hot Percy cautery.

2. Insert a Gilpi self-retaining retractor.

3. Grasp the cervix with a single tenaculum.

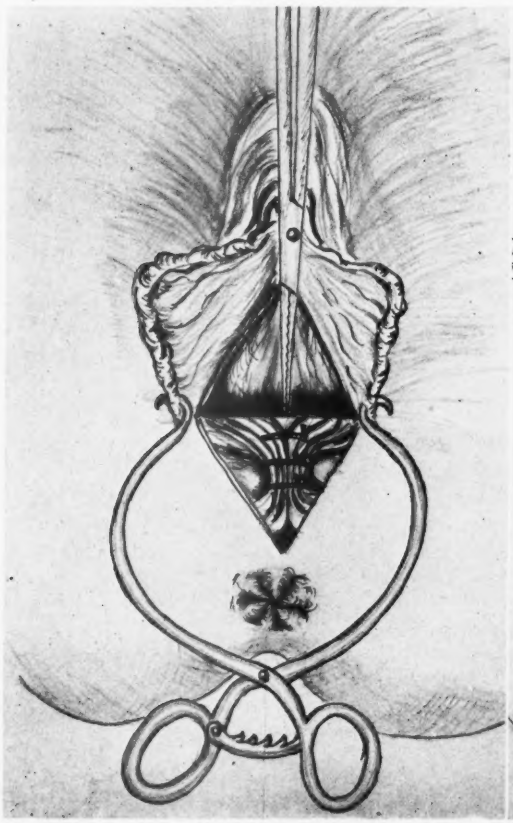

Fig. 9. Levator muscle visualized and sutured median.

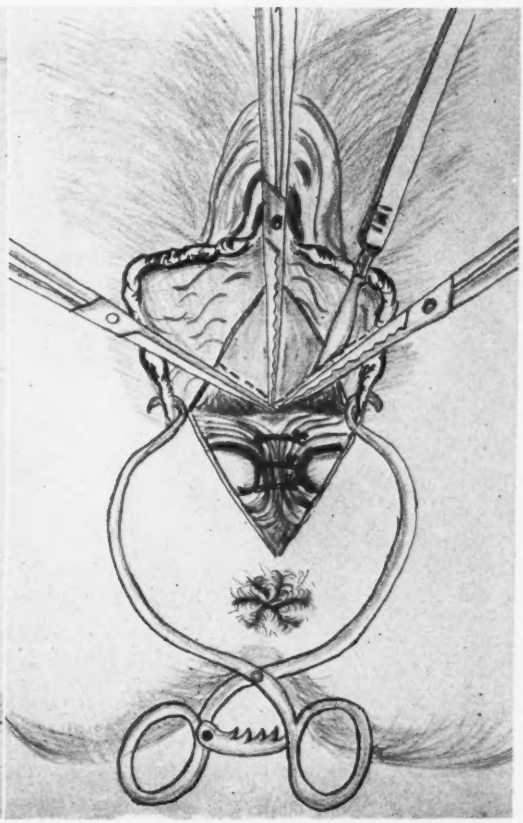

Fig. 10. Two more straight forceps outline the "v" for resection and aid in accurate approximation.

4. Note and demonstrate decensus, cystocele and condition of cervix.

5. If the cervix is cystic (not previously prepared) puncture cysts and cauterize with a red hot Percy cautery (small point), also cauterize canal if eroded or if it is an everted canal with glandular epithelium exposed. It is rarely necessary to do repair of cervix as this treatment takes only one minute or less, and usually produces a better and smoother cervix than cutting.

6. Insert the tenaculum sound and put the uterus down for assistant to hold firmly at all times. (A weighted speculum is not used.)

7. Make an inverted ⊥ (T) incision well up to the urethra.

8. Dissect back the vaginal flap well into the region of the broad ligament laterally and well up to the peri-urethra tissues. A few vessels will be tied in this procedure, especially in the lateral spaces. Fasten the flap by forceps to the sheet or it may be held laterally by an "upstairs" (not sitting) or second assistant.

9. Pick up the bladder and incise cystocervical ligament to begin the upward dissection of bladder. (This "start" is critical for the inexperienced and he may be made to feel safer if he views the tissues laterally in which position light will be transmitted between bladder and cervix.)

10. Carry the bladder dissection well up until the peritoneal reflection is seen. (Note the transparency of the peritoneum and that it slides on the uterus.)

11. Insert a Sim's retractor to pull the bladder well up and back.

12. Pick up the peritoneum and incise with scissors.

13. Replace the Sim's retractor in the peritoneal opening.

14. Examine the adnexa and size of the uterus with a clean finger.

15. Grasp corpus with a single tenaculum by a good deep "bite." Trauma is not passing through the pubovaginal fascia laterally well back (sometimes close to the pubic ramii to get a strong fixed "bite"), and at a level just below the urethra. These

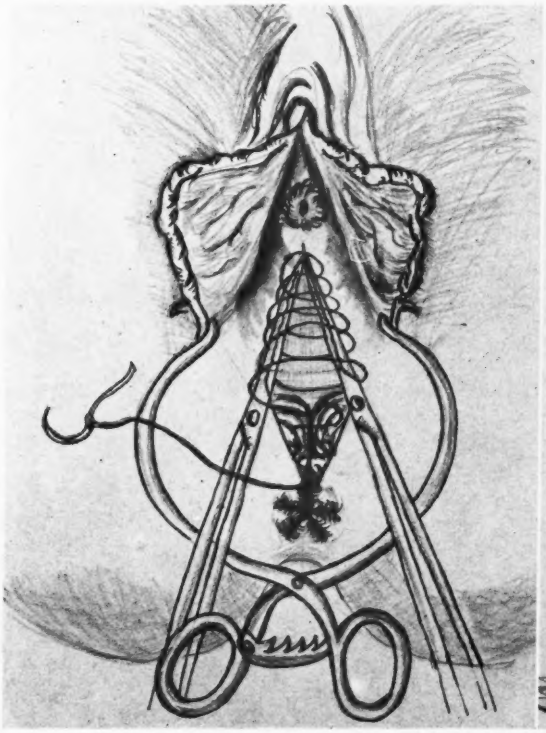

FIG. 11. Flap has been removed and sutures pass over forceps before their removal; the skin is closed with a sub-cuticular application of the same suture.

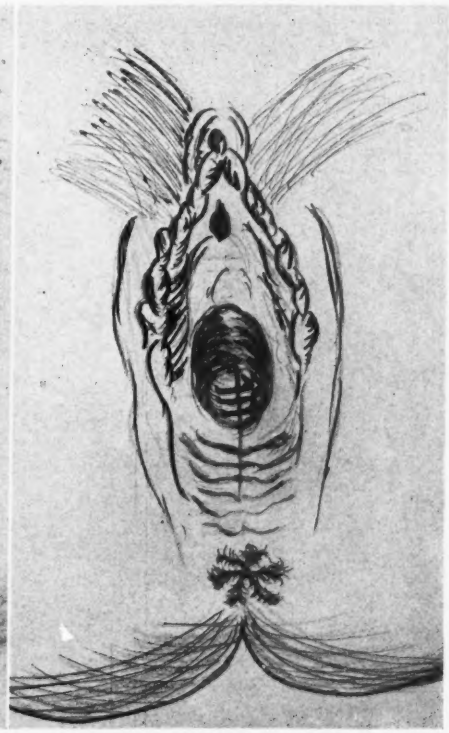

FIG. 12. The perineorrhaphy is completed. *Note:* In these perineorrhaphy drawings the anterior wall has been entirely omitted by the artist.

important as the fundus is to be removed if the patient has a prolapsed uterus or a fibroid; but when only an interposition is to be done to cure the cystocele and a first and second decent, the cat's paw retractor may be used to deliver the small senile corpus without trauma.

16. Remove the tenaculum sound and forceps from the vaginal flap (8).

17. Remove the Sim's retractor and grasp the cervix with a single tenaculum or Allis clamp and "push in" as the corpus is pulled out.

ALL THE ABOVE STEP-BY-STEP TECHNIC IS THE SAME FOR THE INTERPOSITION AND CHAFFIN PROLAPSE OPERATIONS BUT VARY FROM THIS POINT:

A. The interposition operation is completed by inserting two suspension sutures sutures pass through the "high point" of the fundus.

B. Do not tie these suspension sutures but leave sutures loose at this stage.

C. Push fundus back in the abdomen and pull out the cervix.

D. Repair inverted T incision and trim off vaginal wall if indicated. All transverse sutures of the vaginal wall are to include the anterior wall of the cervix. Leave flap unsutured just below urethra.

E. Insert finger into this opening to push the bladder back and tie suspension sutures. Finish the vaginal closure, i.e., unsutured flaps.

F. Perineorrhaphy.

CHAFFIN PROCIDENTIA TECHNIC

18. Pull down the corpus (15) firmly and clamp the broad and round ligaments *en*

masse with straight Oschner forceps, three on each side, close together.

19. Cut between one and two (leave two on ligaments).

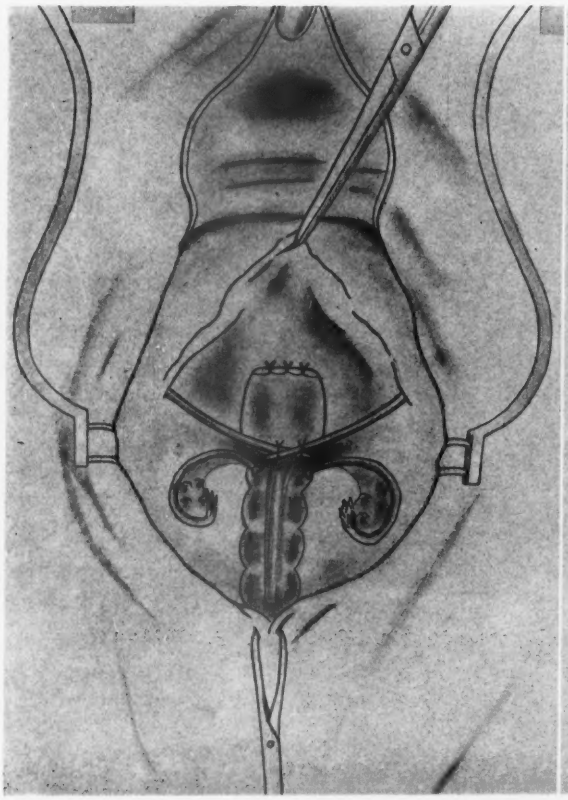

Fig. 13. Abdominal subtotal hysterectomy. The bladder flap held up, cervix has been closed and ligaments anchored low on posterior surface of cervix; about the level of the sacrocervical ligaments. A transverse incision should be made to bury these ligaments at this point. Omit the tubes.

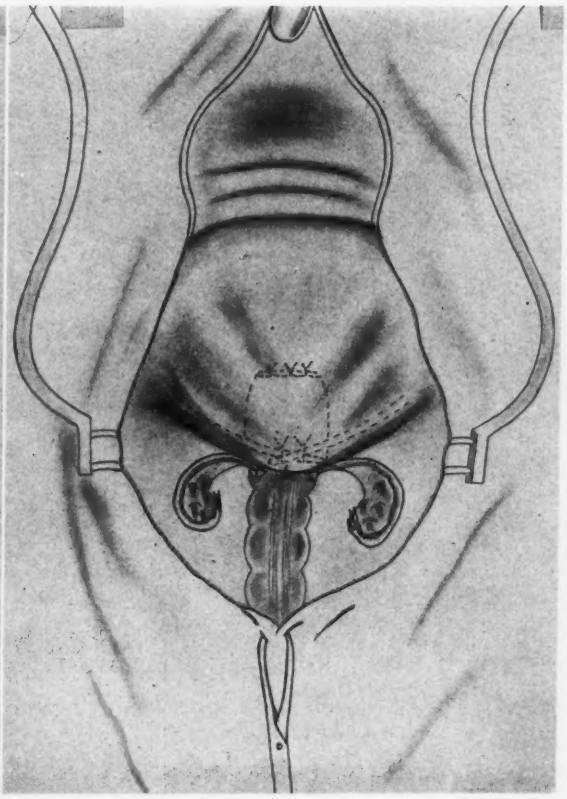

Fig. 14. Same as Figure 13, showing the cervix and ligament "anchor site" covered by the bladder flap. The cervix is free under bladder, ready to be approached from vagina, anterior colpotomy and placing of "interposition" sutures.

20. Clamp the uterine artery at the site of the amputation and remove the fundus.

21. Insert a Percy cautery in the cervical canal to destroy all endocervical mucous membrane.

22. Insert a tenaculum sound in the cervix from above (cut end) and make traction down (assistant holds).

23. Tie ligaments and vessels so that ligaments are mobilized away from the cervix by forcibly "tearing" laterally.

24. The lower end of the cervix covered by the posterior vaginal wall (cul-de-sac tissues) will now be presenting in the field.

25. Denude or incise through into the vagina; if the ligaments are long and a vaginal hernia is present, insert ends of ligaments in incised opening, or if short (moderate prolapse) suture firmly to denuded area.

26. Close the cut (amputated and cauterized) end of the cervix and pass suspension sutures through the pubovaginal fascia and cervix at the site of closure (A).

27. Follow with A, B, C, D and E.

28. Perineorrhaphy is performed by high levatore repair. Catheterize the patient and insert a vaginal pack for twelve to twenty-four hours.

29. Postoperatively, do not allow the bladder to become over-filled and tell the patient and all nurses that a four, six and eight-hour catheterization is probably necessary for several days. Catheterize for residual urine after the patient voids. I like intermittent catheterizations better than

the retention catheter as it makes for less frequency after recovery (optional).

SUMMARY

We have reviewed our results with the "Chaffin vaginal subtotal" operation for prolapse. An analysis appears to disclose that results are superior to any other type of surgery. This technic is again discussed. The explanation and reason are given for the better results. The operation is simple and more easily performed than other vaginal plastic procedures. It is applicable to all ages as it restores and maintains the normal vagina.

CONCLUSIONS

If my readers will carefully study the principles and mechanical factors of prolapse which I have presented, and analyze the operational technic applied, they will arrive at a better understanding of the reasons for which some other procedures failed to succeed. They will appreciate the simplicity of this operation for the treatment of fourth degree prolapse, which proved to be more effective than other methods.

We believe that if this operation is done more often we will not see so large a number of cases of recurrent prolapse of the bladder and vaginal vault, with shorter, dry and excoriated vaginal canals.

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FAILURES IN MAMMAPLASTIC SURGERY

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MANY mistakes in technic and errors of esthetic judgment are made occasionally by surgeons who undertake plastic reconstruction of the female breast. The resultant failures, complications and sequelae disturb and discourage both patient and surgeon.

An analysis of some of the surgical acts of omission and commission will, it is hoped, tend to eliminate the usual untoward results and complications. And in truth, a satisfactory result is one that meets with the purposed esthetic pattern which wholly satisfies the conscientious surgeon, but not always, regrettably enough, the occasionally neurotic patient who requests that the operation be scarless.

Many technical failures are, of course, due—as in other surgical and non-surgical spheres—purely to inexperience. Nothing further need be said on this score. It is rather the avoidable errors of the experienced surgeon in the fields of mammaplastic procedures that require consideration.

Reconstruction of the pendulous hypertrophic, or atrophic breast, is unquestionably a major operation. It is carried out under general anesthesia and under the usual aseptic and antiseptic precautions.

The anatomic structure of the breast, and in particular the blood supply thereof, is of basic surgical importance. It should be recalled that the mammary glands derive their blood supply from the following sources: (1) The internal mammary artery sends five perforating branches to the anterior surface; (2) the external mammary artery, with its external mammary branches, supplies the external and lower part of the gland; (3) the superior thoracic artery sometimes stems directly from the axillary artery; (4) the internal branch of the thoracic-acromio artery; (5) the lateral branches of the second, third and fourth intercostal arteries which supply the posterior aspect of the gland and form an interlacing network for the lobes and lobules; and (6) an artery for the nipple branches directly from the fourth intercostal artery.

A thorough knowledge of the histologic structure of the breast is essential in all surgery of the organ. It must be ever kept in mind that there is a great variation of structure observed even in the normal mammary gland—a degree of variation, according to C. Creighton, "from time to time and from individual to individual which is without parallel in any other mammalian body."

It is axiomatic that the success or failure of any reconstructive or reparative surgical technic depends upon the maintenance of an adequate blood supply. If this is interfered with seriously, the result is put in jeopardy and is sometimes disastrous.

Nearly all failures in mammaplastic surgery are due to post-surgical complications which are mainly consequent upon: (1) Hemorrhage, (2) liquefaction of fatty tissue, (3) infection, sloughing and gangrene of skin, breast tissue, or both areola and nipple.

Secondary hemorrhage sometimes occurs in all instances, and in all areas, where incisions are made. It is of utmost importance to ligate even the smallest "bleeder" carefully and at any stage of the operation the exposed area must be thoroughly examined for the source of further oozing. Bleeding ordinarily occurs lateral to the serratus muscle and along the upper margin of the mammary gland (branches of the internal mammary artery.)

Bleeding is definitely increased during the premenstrual day and during menstruation. The optimal time for mammaplastic surgery is, therefore, the second following week. All other causes which may increase bleeding during the operation must be anticipated and adequately met. It is likewise unwise to operate shortly after pregnancy, that is, before complete uterine involution has taken place.

Secondary hemorrhage, with clot formation, is often responsible for the ruin of an otherwise successful mammaplasty. The normal blood circulation to contiguous and circumjacent tissues is interfered with. An infarct of variable dimensions frequently results, with eventual necrosis and sloughing. A blood clot along the line of internal catgut sutures, for example, will loosen the strands and transform

Fig. 1. Asymmetric placement of nipples with keloidal scars after buttonhole technic.

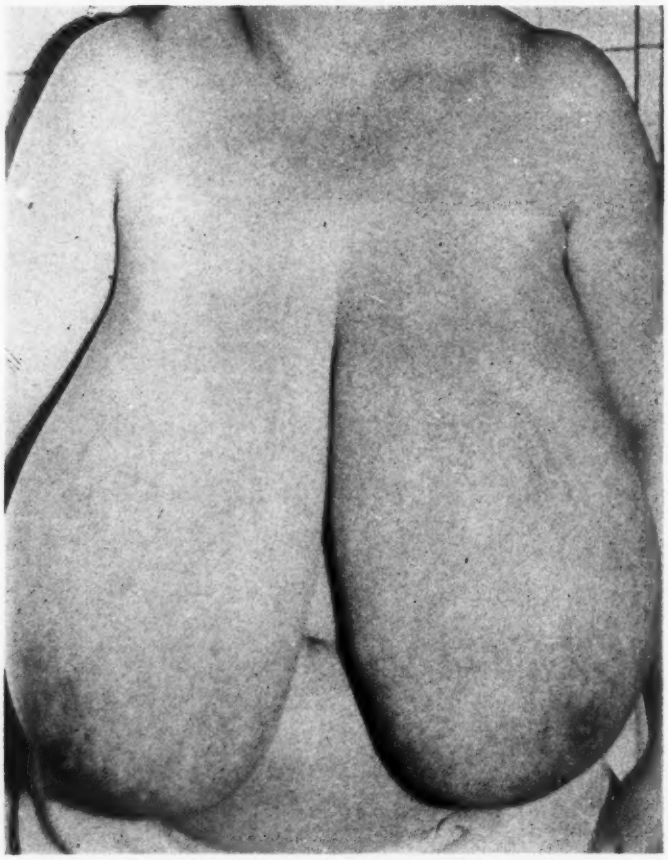

Fig. 2. Unsuitable case for mammaplasty.

them into foreign bodies. These produce local changes, impairment of healing and an unsatisfactory result.

Regulation of blood pressure before operation is absolutely essential as well as an appraisal of the patient's general condition and her metabolic rate.

The most common complication in mammaplasty is fatty tissue liquefaction. This may not be manifest for weeks or even months. In most diffuse, hypertrophic breasts the glandular tissue has been relatively lost and substituted by degenerate fatty tissue. This variety tends to break or destroy the surrounding cell membranes and to liquefy its contents. The change is similar in some respects, to that which occurs in the formation of an abscess. Inflammatory reaction sets in with the usual temperature rise, which is sometimes high and accompanied by chills. This sterile abscess of liquefied tissue must be opened and drained under the most thorough aseptic precautions. The symptoms then ordinarily disappear. It is extremely doubtful if these post-surgical abscesses can always be prevented. It is imperative during the operation to maintain proper temperature by continuous application of body-temperature compresses to the surgical area. The time element is an important factor. Exposure of breast tissue should be of minimum duration as is consistent with a speedy technic.

It is of prime importance that the surgeon be familiar with the aforementioned complication and not to mistake it for an actual infection. The patient, too, should have a clear understanding of the nature of the sterile abscess.

When a post-surgical infection occurs, it must be treated like any other infection of a similar nature in general surgery. The use of one of the sulfonamide group of drugs will be found effective.

The surgeon is often confronted with the problem of tissue necrosis which may be due either to inadequate, or destroyed, arterial blood supply of main branches, or to venous congestion consequent upon secondary hemorrhage or even mere oozing. No part of the mammary

Fig. 3. Superficial necrosis of lower part of areola two weeks after mammaplasty.

gland after surgery is exempt from such a complication. In some instances only a small area of skin is involved. Sloughing, as a result, occurs along suture lines. (Fig. 1.) The skin appears whitish. Soon a bluish, necrotic demarcation takes place and the necrotic skin can then be excised. Healing takes place in the normal manner. Sloughing of skin only, however, is extremely rare. In most instances the obstruction of blood circulation starts somewhere within the breast tissue. The process of demarcation takes a much longer time and usually includes the integument. When sloughing of breast tissue occurs only below the external suture lines, the skin proper may not be involved. Sloughing ordinarily occurs in the upper, lateral quadrant of the breast along the edges of the underlying serratus muscle. Radial sloughing is the most frequent. Six to eight days after the operation this area appears grayish-white, cold and anesthetic. The patient complains of a sense of great weight in the breast. The necrosis

takes its usual course and it is advisable to accelerate the demarcation by infra-red radiations and application of balsam of Peru along the delineating edges.

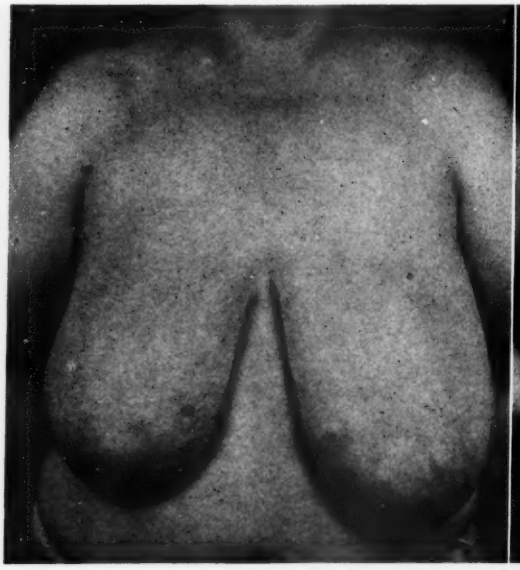

Fig. 4. Hypertrophied breasts showing extensive varicosities.

Fig. 5. Same patient as in Figure 4 showing beginning, complete necrosis of right, and incomplete necrosis of left nipple.

The isolated zone of tissue is excised under aseptic conditions. The shape of the breast after this excision can be maintained by tight strapping with sterile adhesive tape, which approximates the areas between healthy tissue and healthy skin. Sloughing of areola and nipple is the most serious complication in mammaplastic surgery and certainly the nightmare of every surgeon engaged in that field. The first sign is nearly always observed at the first dressing, which is usually changed within twenty-four hours after the operation. Nipple and areola, which normally are pinkish and brownish, appear dark blue or purplish and sometimes almost black. This is the great danger signal of beginning necrosis of both areas. If, at this stage, proper medical treatment is not administered or proves ineffective, surgeon and patient will go through many disturbing weeks or months. The destruction usually includes a circular wedge of underlying breast tissue. A crater-like necrosis finally appears involving the confluent lobar and lobular ducts. This is painless but the patient must be frankly informed of the serious nature of the complication.

If the bluish discoloration of nipple and areola appears at the first dressing, the surgeon can utilize one or more of three restorative measures as regards the blood circulation. These are: (1) Removal of interrupted sutures and manual expulsion of blood clots which may be responsible for the decreased blood supply; (2) increase of arterial blood supply by artificial hyperemia produced with infra-red radiation, or application of frequently renewed alcohol sponges, or hot poultices, and (3) application of leeches (highly effective) directly in and around the discolored area. (Leeches, incidentally, inject the chemical substance Hirudine into the bloodstream which prevents coagulation for about eight hours. To be beneficial they must be applied within twenty-four hours after the operation.) Sterile compresses to absorb the slowly flowing blood should be used continuously.

The changes brought about are sometimes truly miraculous. Normal color appears within areola and nipple and the complication clears up. The best systemic

indication of this is a lowering of the temperature curve.

Where plastic reconstruction requires resection of a small segment of breast tissue only, the temperature following the operation, in the absence of complications, remains almost normal. In diffusely hypertrophied mamma ("heavy breasts"), which requires extensive resection consisting mostly of fatty, degenerated tissue, a rise of temperature up to 102°F. after the operation is often noted. This is due to resorption of small fatty or necrotic particles and exceedingly minute blood clots. If the temperature elevation is concurrent with a bluish discoloration of areola and nipple, observed at the first dressing, the success of the application of the aforementioned remedial measures will be shown by a restoration of the normal coloration to the part. An elevation of temperature to 104°F. or more is indicative of progressive necrosis of areola and nipple.

While sloughing of an area of breast skin reduces the size of the gland it does not interfere subsequently with function. Necrosis of areola and nipple, however, leaves the gland functionless.

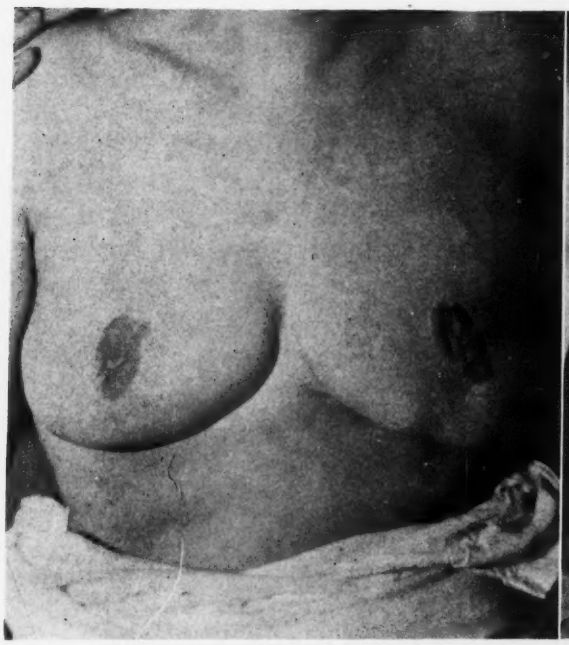

Fig. 6. Almost total loss of both nipples after mammaplasty (buttonhole technic).

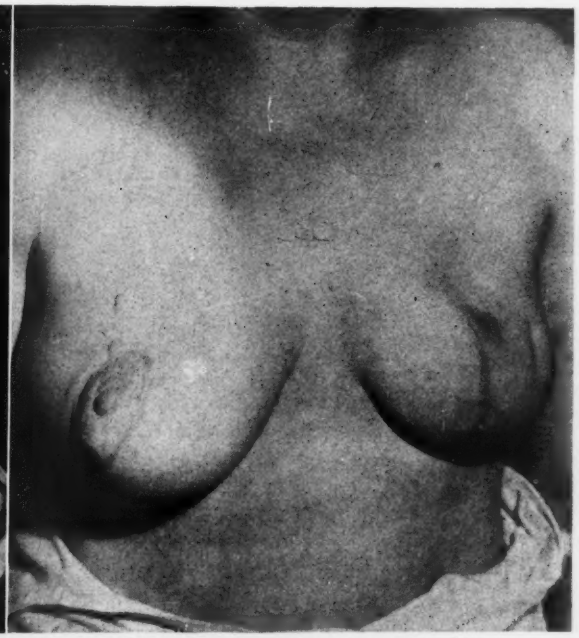

Fig. 7. Extensive sloughing of right breast, fatty abscess of left breast with a resultant misplacement of both nipples.

In some instances, an apparent necrosis solely of the nipple is evident at the first change of dressing. Application of one leech to the affected area may save the blood circulation of the nipple. If this fails, the necrosis only involves the epidermis of the nipple and does not interfere with the function of the mammary gland.

Sometimes discoloration and signs of beginning necrosis appear only along the suture line around the areola, while the nipple and center of the areola are of normal color. Here, immediate removal of sutures is indicated as well as infra-red radiation.

Progressive gangrene of the mammary gland is a rare complication. I have seen only one case and know of only two others. In the three, the complication took the same course. Primary healing of incisions took place at first; then suddenly, on the tenth or eleventh post-surgical day, somewhere along the surface, a "dime-sized" bluish gray spot appeared. The patient felt sick and nauseated. The temperature was only slightly elevated. Within two or three days the skin broke and discharged a thick, fetid pus containing leucocytes,

cell fragments and low-grade bacteria. Within a few days a similar change took place an inch, or half an inch apart, from

Fig. 8. Asymmetric implantation of nipples with subsequent sloughing.

the primary area. Soon grayish spots were noted within and outside of the entire surgical field toward the axilla, clavicle, sternum and abdomen. In the case I saw in consultation, the entire breast, including the skin, sloughed off over a period of six or seven months. However, both nipples remained intact with a strand of fibrous tissue extending to the lower aspect of the mammary gland area. For repair the entire involved skin was excised and an abdominal skin graft was attached to the remaining areola and nipple.

In one case, on the sixth post-surgical day, the entire upper half of the left breast appeared bluish-white. It was clammy and apparently revealed a beginning necrosis. After application of tyrode modification over the involved area the process regressed to normal in twenty-four hours; the skin discoloration disappeared and healing took a normal course. Another patient's breast apparently healed without complications. She had been discharged but returned during the seventh post-surgical week. The outer half of the right breast showed bluish and purplish discoloration, swelling and inflammation. In the middle of the breast (toward the mid-axillary line) a liquefactive focus appeared

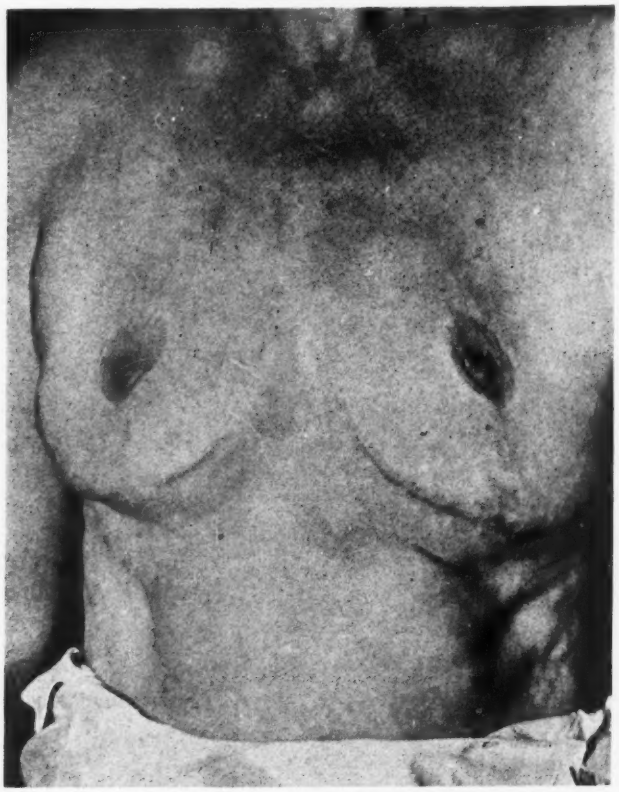

Fig. 9. Striking failure in mammaplasty—"pancake" effect.

and indicated incision and drainage. Instead I applied tyrode modification over the entire area. After 24 hours the swelling was greatly reduced, the area of liquefaction was treated daily and in two weeks normal circulation was restored and a gratifying result obtained.

CONCLUSIONS

The early recognition by the surgeon of complications and prompt attention are helpful in eliminating them and obtaining gratifying results from a surgical and cosmetic viewpoint.

Biesenberger's criteria of an absolutely satisfactory mammaplastic result should be kept in mind: (1) The removal of breast deformity and construction of a youthful, natural and cosmetically satisfactory form by reduction in size to normal dimensions according to the general proportions of the body; (2) symmetry; (3) preservation and transplantation of nipple and areola to their relative normal locations, increasing at the same time the areola in proportion to the newly formed breast volume; (4) prevention of possible obstruction of the blood circulation, above all, of the areola and nipple; (5) avoidance of interference with organic function; (6) avoidance of forming scars readily visible in clothes, particularly above the nipple; (7) use of a systematic surgical technic which can be carried out in all breast forms and dimensions, thereby facilitating adjustments to individual esthetic requirements; (8) one-stage operation; (9) proper use of elastic pressure bandages, and (10) careful elimination of unsuitable cases for psychic and physical reasons.

FACTORS IN MALE STERILITY*

A CRITICAL REVIEW OF 135 CASES

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INTEREST in the study of sterility in the male has been stimulated by advances in diagnostic methods and endocrinological therapy. Investigators have stressed the necessity for detailed study of the sterile male and comprehensive consideration of all factors contributing to infertility. The extensive researches of Moench, Hotchkiss, and Portnoy[4] repeatedly emphasize the need for technical skill and understanding in interpretation of complete semen analyses. Despite recent contribution to our comprehension of the problem, there still remain many important questions in need of answer. The present study is based on examination and follow-up for five years of 135 cases with critical analyses of 500 semen specimens. In every instance, the marital mate was studied coincidently by competent gynecological authority.

This work early suggested the necessity for meticulous study of the sperm morphology since approximately 20 per cent of the patients whom we found deficient in fertility had previously been adjudged normal. Therefore, classification of this series is based primarily on sperm count and morphological characteristics. Obvious congenital causes of sterility, such as, hypospadias, cryptorchidism, and abnormal attachment of the epididymis to the testis are granted no special emphasis since the problem is immediately apparent. We have concentrated rather on the cases in which diagnosis is obscure and pathological states are not readily identified.

METHODS OF INVESTIGATION

The evaluation of male responsibility in the barren marriage is approached in our clinic with careful appraisal of all factors contributing to sterility. A systematized and routine form is essential. Thus a careful medical history is taken with emphasis on endocrinological and sexual factors. Physical examination is thorough and includes when necessary cystoscopic examination and catheterization of ejaculatory ducts. If abnormality is detected, *x*-ray and laboratory studies as may be indicated are made. In every case at least two semen specimens are taken; these are obtained by withdrawal and ejaculation into a glass container after the patient has abstained from intercourse for five days. The specimen is examined preferably within an hour or two for motility, volume, count, mucolysis, and differential morphological study. Criteria of morphology are those established by Pollak and Joel.[13] (Fig. 1.)

Motility of the sperm is determined by examination of a hanging drop and a calculation of the numbers of sperm which cross one-quarter of the microscopic field through an Ehrlich ocular screen in ten seconds. The ratio of this figure compared to the total number of sperm in the field provides the percentage of motility. A percentage of eighty or more after two hours is considered 4 plus; sixty to eighty 3 plus; forty to sixty 2 plus; and twenty to forty 1 plus.

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To determine the total sperm count, a well shaken specimen is drawn up to the 0.05 mark of a red cell pipette. A diluting fluid consisting of a 4 per cent boric acid and 1 per cent phenol is then drawn up to the 1.01 mark. The mixture is shaken well, and a drop is placed on an improved Neubauer hemocytometer. Five of the red cell counting squares are calculated (one from each corner and one from the center to insure an average result). Six zeros (10^5) are added to the total figure which gives the number of sperm per cc. Counts of 60 million to 120 million are considered normal.[9]

For histologic study a seminal smear is made and fixed by heat. MacNeal tetrachrome stain is applied for three minutes after which distilled water is added for two minutes longer. The smear is then washed and dried and excellent visualization of the entire field is accomplished with this simple stain. The nuclei appear blue; cytoplasm, neck, and tail are strikingly pink. The routine use of this stain for seminal smear was initiated in our clinic. We consider a seminal specimen to be morphologically abnormal if there are more than 30 per cent of abnormal forms.

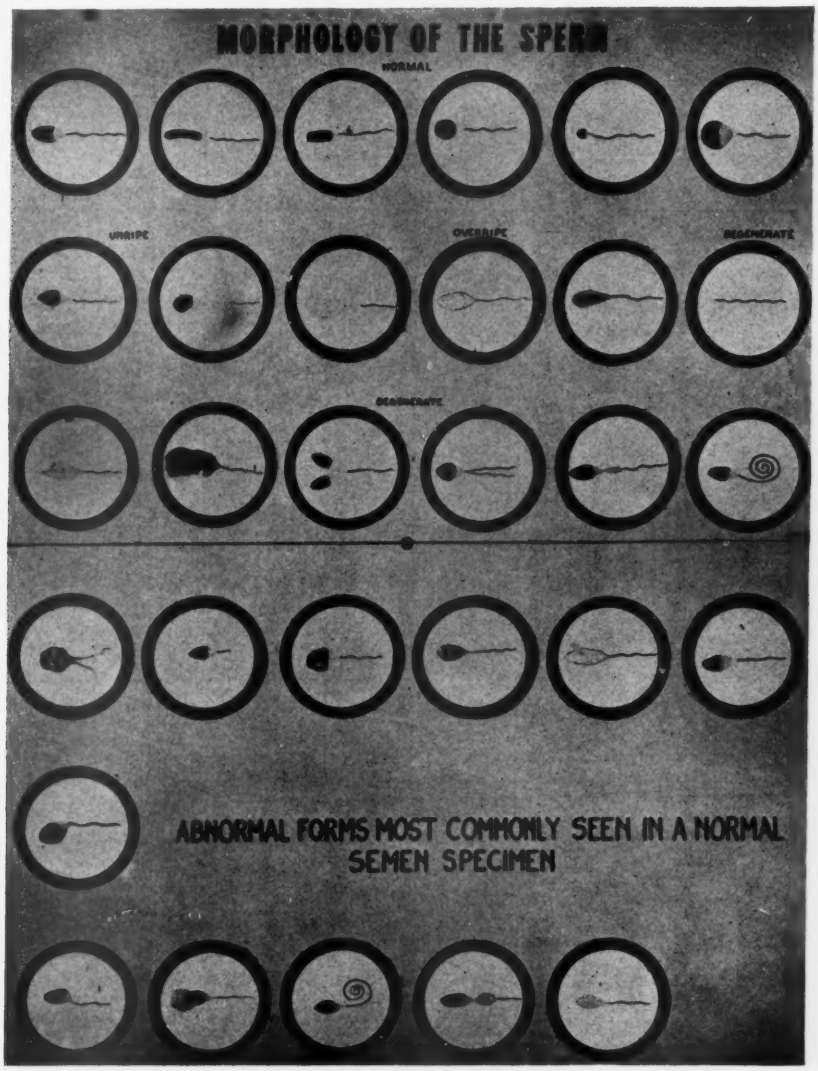

Fig. 1.

CLASSIFICATION OF CASES

Detailed analysis of 135 consecutive cases of sterile marriage indicated to us

that categorical classification in determination of male responsibility could be based on total sperm count and differential morphological examination of seminal fluid. Therefore, division was made into the following groups: (1) Normal semen analysis; (2) normal count; increased number of abnormal forms; (3) decreased count with increase in abnormal forms, and (4) azoospermia. (Fig. 2.)

	Number of cases	Percentage	Range of total count	Activity	% of abnormal forms	Semen Analyses	Testicular Biopsy	Pregnancy	Infertility of mate
NORMAL	43	32	134 to 751 million	3 plus to 4 plus	9-30	102	0	10	19
LOW COUNT ABNORMAL MORPHOLOGY	34	25	1 to 69 million	0 to 2 plus	30-90	153	9	6	4
NORMAL COUNT ABNORMAL MORPHOLOGY	34	25	117 to 632 million	3 plus to 4 plus	35-81	167	6	9	1
AZOOSPERMIA	25	18	0	0	--	78	10	1	0
TOTAL	135					500	25	25	24

FIG. 2. Classification of cases.

The factors of motility and viability have been stressed by most investigators. Our experience has shown that in only rare cases in which there were normal count and normal morphology was there complete absence of motility. Impairment of motility indicated in most instances other defects. As regards viability, this series reveals striking variation with conception taking place where sperm activity was noted for only six hours. The usual range for the fertile specimen was found to be eight to thirty-six hours. Where abnormality was detected in count and morphology, corresponding failure in viability occurred. However, it must be emphasized that in a group of cases in which viability and motility were normal, there was an increase in abnormal forms, this factor being accountable for infertility.

NORMAL SEMEN ANALYSIS

This group comprises 32 per cent of the cases studied. Meaker and Vose[10] report that in seventy-eight out of one hundred cases the responsibility for infertility was divided between husband and wife. They state that of all fruitless marriages, 30 per cent of pathologic conditions occur on the male side. Our series suggests that 68 per cent of the males showed defective semen.

Many of the subjects in this category were referred to us because their wives were undergoing concurrent studies by

gynecologists and infertility had not been definitely established in the female. In nineteen instances, the female had later

factors are responsible for a certain number of these cases. In many no one etiologic basis could be determined. Biopsy of the

REDUCED COUNT WITH REDUCTION IN ABNORMAL FORMS

NAME	DATE	COUNT PER C.C.	TOTAL COUNT	MOTILITY	VOLUME	% OF ABNORM. FORMS	ABNORMAL FORMS										
							HEAD CYTOPL.	NECK CYTOPL.	VACUOLES	PINHEAD	DEFORMED HEAD	APLASTIC	DOUBLE HEAD	TRICK NECK	DEFORMED NECK	DOUBLE TAIL	COILED TAIL
F.J.	5-4-4	68	190M	2+	2.8cc	39	7	7	13	0	4	0	0	0	4	1	3
	5-25-4	73	113M	3+	1.6cc	23	6	3	6	0	5	0	0	0	4	1	2
E.B	2-15-40	78	452	2+	58	81	0	15	18	0	17	4	0	11	0	3	13
	3-28-40	70	350	3+	5	78	0	12	28	2	11	3	3	0	7	0	12
	4-25-40	59	322	3+	58	38	0	3	12	0	10	3	2	0	3	0	5

Fig. 3.

been found deficient. However, the phenomenon of sterility resulting in a marriage in which both partners were physiologically normal is not unknown and this point is further emphasized in the current study. Factors as yet uncovered are responsible for these fruitless unions. In ten cases pregnancy subsequently occurred.

It is interesting to note that in several instances in which sterility was placed on the basis of low sperm count, although differential studies were normal, conception took place. Our standards for total sperm count, therefore, are much lower than those suggested by many investigators. Hotchkiss[5] has found in the fertile male counts as low as 3,250,000 per cc. Of 200 men whose wives were pregnant, 25 per cent had counts below 60,000,000 per cc.

LOW COUNT HIGH PERCENTAGE OF ABNORMAL FORMS (USUALLY WITH DECREASE IN MOTILITY)

In this division, etiology is variable and many responsible factors could be established. Thus in certain instances improvement resulted when foci of infection were discovered and cleared. This was true whether infection was confined to the prostate or seminal vesicles or resided in a distant focus. Circulatory disturbance to the testicle can provoke such irregularity. It is our impression that endocrinological testicle in this group is a worthwhile diagnostic adjunct.

Our studies in general affirm the contention that there is an increase in abnormal forms with decreased count and conversely that there is a decrease in abnormal forms with increased counts. However, there are so many exceptions to this rule that one cannot make a universal application of this general principle. Figure 3 demonstrates two specific instances in which reduction in total count was accompanied by a reduction in percentage of abnormal spermatozoa. Figure 4 shows even more graphically how in the same patient variation in total count bore direct mathematical relationship to the percentage of abnormal forms.

It is significant that physical examination failed to disclose evident testicular disorders corroborating the opinion of Hotchkiss.[3]

NORMAL COUNT—HIGH PERCENTAGE OF ABNORMAL FORMS

The third group is comprised of those patients whose seminal deficiency is revealed only by morphological studies of the sperm. All other factors meet normal standards but there is an inordinate number of abnormal forms. There were thirty-four such cases or 25 per cent of the total series. It is in this group that diagnosis is most often missed because motility and

total sperm count give no clue to the irregularity. Many cases in this category had been declared normal by other observers because careful morphologic studies had not been done. Since the sperm in these cases remained viable from eight to twenty-four hours, it is logical to assume that in specimens containing a high percentage of abnormal forms the spermatozoa may remain motile as long as sperm in normal specimens. Weisman[15] holds a contrary opinion.

It is realized from observation of this group that positive interpretation of Huhner's test[6] may be in error. Sperm may be present at the cervix in sufficient number with adequate motility but the test may be faulty because of the presence of an excessive number of abnormal forms. Any test which does not take into consideration the morphology of sperm may be wrongly interpreted.

Figure 5 represents a case originally adjudged normal since quantity and motility were within normal range but detailed examination of semen disclosed an excessive number of abnormal spermatozoa.

As yet testicular biopsy in this division does not add to our information since biopsy in six cases revealed normal spermatogenesis. In eight instances conception ultimately occurred.

Etiology is often elusive and there are apparently many factors causing a high number of abnormal forms. Some cases are the result of endocrine deficiency, others are due to foci of infection, exposure to *x*-rays, or dietary deficiencies. It is interesting to note that in the two patients who were exposed to *x*-rays, residents in radiology, semen analyses showed a large number of sperm with excellent motility. The abnormal forms were mainly in the immature group, that is, those with cytoplasmic remains about the head and neck. The *x*-ray apparently had a stimulating effect producing an increase in spermatogenesis with the production of young forms. In those cases in which spermatogenesis is sluggish as demonstrated by low count, decreased motility or overripe forms, *x*-ray therapy in controlled dosage may be of value.

The following cases selected from this group are illustrative of successful therapy:

INCREASED COUNT WITH INCREASE IN ABNORMAL FORMS-

NAME	DATE	VOLUME	MOTILITY	COUNT PER C.C.	TOTAL COUNT	% ABN FORMS	HEAD CYTOPL.	NECK CYTOPL.	VACUOLE	PIN HEAD	DEFORM. HEAD	AMORPH.	DOUBLE HEAD	THICK NECK	DEFORM. NECK	DOUBLE TAIL	COILED TAIL
S.K.	8-27-40	3.0	3+	66	198	39	4	9	9	0	8	1	0	3	2	0	3
	10-25-40	3.5	4+	79	277	42	8	8	16	0	7	0	0	2	1	0	0
	12-12-40	3.5	4+	82	287	72	23	17	14	0	7	0	0	5	3	0	2

Fig. 4.

CASE REPORTS

Case 1. This was a barren marriage for three years. The wife was declared normal by a gynecologist; the husband was negative on physical examination but his basal metabolism was −28. The initial sperm analysis showed 56 per cent of abnormal forms. With gonadogen and thyroid medication, morphology was restored to normal. After eight months of therapy the wife conceived.

Case 11. This had been a sterile marriage for three years. Physical examination of the husband revealed no positive finding. His basal metabolism was −30. Previous seminal examinations were cursory and the patient had been thought normal. Originally 61 per cent of abnormal forms were seen on semen smear. The wife had had every test for fertility including tubal insufflation, endometrial biopsy, and Huhner's test and in every respect was declared normal. The patient was treated with thyroid

gr. 1¼ daily. The wife became pregnant after nine months of treatment.

AZOOSPERMIA

Of all the problems in male sterility, diagnosis in this group is simplest since absence of sperm count can readily be demonstrated. These cases fall into two groups: (1) Obstructive, in which blockage anywhere along the genital pathway prevents the appearance of sperm in the ejaculate; (2) degenerative, in which disturbance in the reproductive mechanism due to any cause prohibits the formation of spermatozoa.

Of the twenty-four cases reviewed, fourteen could be placed on a degenerative basis and ten on an obstructive. Differentiation between these two types can best be established by testicular biopsy. (Figs. 6 and 7.)

In the degenerative group, the etiologic factor could be determined in eight cases. Of these three had had mumps with complicating orchitis. One patient gave a history of seminoma with subsequent radiation therapy. In one instance it was discovered that both testes were intra-abdominal. It was possible to ascertain definitely that three such cases were referable to endocrinological dysfunction. The etiologic background of six patients was never established. In only one case (Fig. 8) was improvement noted. A thirty-five year old male whose physical examination afforded no significant findings was found on initial analyses to have azoospermia. Complete studies revealed only a lowered basal metabolic rate (−15). He was placed on therapy consisting of thyroid extract, corticosterone, and gonadogen. One month after the inception of therapy, a few dead sperm were visualized in the semen. Gradually improvement occurred in number, motility, and percentage of abnormal forms. Examination of the chart reveals that change in type of abnormality followed a definite pattern. There is a progressive shift from the large number of degenerative sperm to the type of alteration seen in the abnormal form which is commonly found in the fertile specimen (i.e., vacuo-

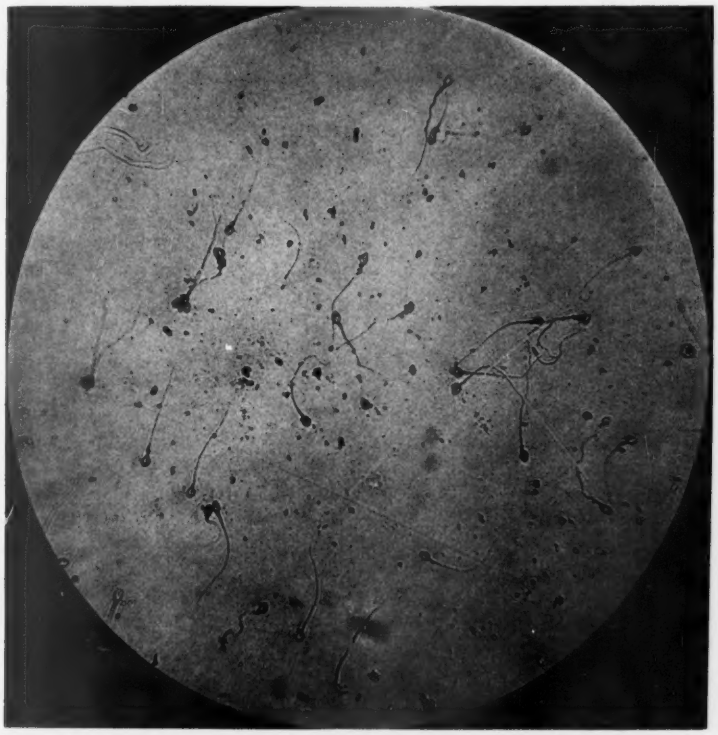

Fig. 5. Microphotograph of seminal smear revealing high percentage of abnormal forms.

lated and those with cytoplasmic remains about the head and neck). After two years of treatment conception occurred.

spermia in which recovery of spermatozoa in the aspirate implied the presence of obstruction in the seminal tract. While rep-

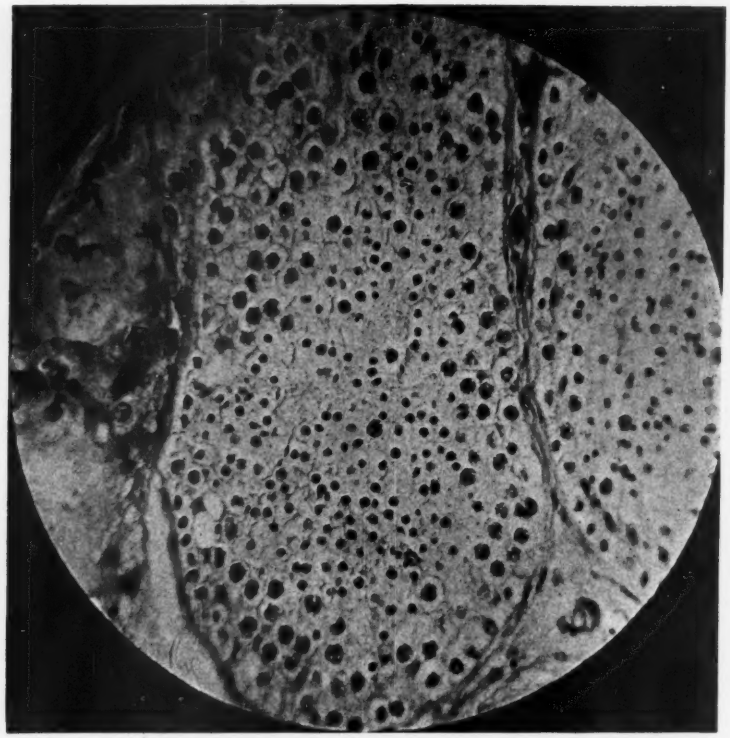

FIG. 6. Microphotograph of testicular biopsy showing normal spermatogenesis.

In all obstructive cases infection with secondary epididymitis was established as the etiologic background. The site of blockage was not always demonstrated. It is in this group particularly that exploration of the ejaculatory ducts may be of value. In four cases epididymovasostomy was performed, but in none of these were successful results procured.

Although prognosis in cases of azoospermia is very poor, we feel that in rare instances improvement may occur as suggested in the reported case.

TESTICULAR BIOPSY

Although the microscopic examination of testicular tissue had long been recognized as a valuable diagnostic measure in consideration of male infertility, no step was taken in this direction until 1913 when Huhner[7] introduced testicular aspiration. He advocated its use in instances of azoo-

resenting an advance, this test had certain cardinal deficiencies. It often happened that for technical reasons no secretion was obtained. Inaccuracies sometimes resulted because puncture was made in a zone where seminiferous tubules were relatively inactive although elsewhere advanced spermatogenesis was present. The test was of value only in demonstrating the presence or absence of obstruction but made no effort to define intrinsic lesions of the seminiferous tubules. The microscopic examination of the testicular tissue removed by biopsy was introduced clinically by Hotchkiss to overcome these limitations of aspiration.

Testicular biopsy is a simple technical procedure. After preparation of the field, 5 cc. of 10 per cent novocaine are injected into the spermatic cord and over the site of incision. After an interval of fifteen minutes, an incision 1 cm. in length is made

down to the tunica albuginea which is nicked. A bit of the protruding testicular tissue is excised and immediately sent to the laboratory for histologic examination. One suture is placed through the tunica albuginea and the skin is closed with one or two black silk sutures. This technic is painless, brief, and accompanied by no postoperative distress. Charny[1] lists the following indications for testicular biopsy: (1) In azoospermia to differentiate between the obstructive and nonobstructive types; (2) to determine severity of pathologic process; (3) as a prognostic gauge, to determine the capacity of tubules to regenerate, and (4) as a therapeutic measure, to evaluate by repeated biopsies the efficacy of therapy.

We have performed testicular biopsy in twenty-five cases and have found a striking relationship between semen analysis and the findings of microscopic examination of testicular tissue. In a series of ninety-five cases Charny and Meranze[2] have found correlation in 87 per cent. The following illustrative cases demonstrate the significance of testicular biopsy.

Fig. 7. Testicular biopsy with evidence of marked testicular degeneration. Only spermatagonia with thickened basal membrane are seen.

Case III. This was a sterile marriage for five years. The male was in good health. Physical examination, laboratory and metabolic studies were negative. Semen examination revealed no sperm. Catheterization of ejaculatory ducts showed no obstruction. Testicular biopsy disclosed marked degeneration of the tubules showing only the basal layer of cells.

In this case therapy could be of no value because of the marked degeneration of testicular tissue. No therapeutic agent could restore such a striking atrophy.

Case IV. This was a sterile marriage of four years' duration. The husband had had gonorrheal epididymitis five years prior to examination. Physical examination was normal. Semen analysis showed no sperm. Needling of the testicle was ineffective. Testicular biopsy revealed normal spermatogenesis and normal interstitial cells. In this patient sterility was therefore due to a block in the seminal tract. If obstruction could be overcome, conception would occur.

These cases illustrate the value of biopsy in differentiation between obstructive and degenerative lesions of the testicle.

noted, adequate endocrine therapy produced dramatic results. It should be pointed out, however, that these cases

GENERATION OF SPERM SHOWING CHANGES IN ABNORMAL FORM TYPES WITH IMPROVEMENT

NAME	DATE	QUANTITY	MOTILITY	COUNT PER C.C.	TOTAL COUNT	% ABN. FORMS												
M.W.	12-26-39	2.0cc	NO SPERM						NO SPERM									
	1-29-40	2.0cc	OCCAS. DEAD SPERM															
	2-2-40	3.5cc	FEW INACTIVE SPERM	5M	14M	75	5	6	15	6	7	16	0	4	4	6	4	
	2-9-40	3.5cc	4+ 5 ACTIVE SPERM PER FIELD	5M	17M	85	7	10	10	10	15	10	15	0	5	1	7	
	3-27-40	4.0cc	1+	34M	136M	81	0	8	22	10	16	17	0	0	6	0	2	
	4-11-40	2.6cc	2+	33M	86M	65	3	12	2	13	12	12	0	1	7	2	1	
	8-22-40	3.0cc	2+	32M	96M	59	10	7	11	0	18	6	0	2	4	0	1	
	10-17-40	3.0cc	2+	14M	42M	61	7	4	14	0	16	16	0	1	2	0	1	
	2-11-41	2.0cc	2+	23M	46M	68	8	11	17	2	15	8	0	0	4	0	3	
	4-2-41	2.8cc	2+	19M	54M	69	21	17	18	0	3	3	0	1	2	0	4	
	5-15-41	3.0cc	2+	32M	96M	77	34	9	19	1	4	6	0	0	1	0	3	
	7-16-41	3.1cc	3+	47M	146M	64	30	8	18	0	1	4	0	0	0	0	3	
	9-9-41	2.5cc	3+	41M	102M	56	15	7	25	0	0	2	2	1	0	1	3	
	11-13-41	2.9cc	3+	37M	107M	52	17	7	23	0	0	3	0	0	0	2	0	
	3-5-42	3cc	4+	47M	141M	49	18	6	19	0	0	2	1	1	0	0	2	
	4-26-42	2.4cc	4+	31M	74M	46	16	4	16	0	2	2	0	2	3	0	1	
	10-27-42	2.8cc	4+	45M	135M	44	18	5	16	0	2	3	0	2	2	0	0	
	4-6-43	2.0cc	4+	51M	102M	26	7	2	6	0	2	2	0	3	2	0	2	
	5-5-43	2 cc	4+	59M	106M	23	8	4	3	0	3	1	0	2	1	1	1	

WIFE CONCEIVED

FIG. 8. Case of degenerative azoospermia with ultimate fertility demonstrating phenomenon of "shift to left."

CASE V. This was a sterile marriage for six years. The husband had been declared normal when cursory semen analysis showed active and motile sperm. A detailed study, however, indicated that the sperm count was reduced, and differential morphologic count showed a preponderance of abnormal forms. Testicular biopsy disclosed vacuolization and slight degeneration of the tubules with spermatogenesis occurring in diminished form.

Hormal stimulative therapy has precise indication in a case of this sort.

TREATMENT

In those cases in which seminal inadequacy was thought to be due to excessive indulgence in sexual intercourse, abstinence for several weeks was advised with gratifying results in several instances. As has been shown in animal experimentation sexual overloading will produce an increase in abnormal forms as well as a decrease in the number of sperm.

When a definite endocrine deficiency was were comparatively few. A low basal metabolic rate was found in many cases in which seminal secretions were normal. When hypothyroidism was definitely established, the results with thyroid medication were good. In certain cases, gonadotropins were administered as adjunct therapy. In those cases in which no evidence of thyroid deficiency could be demonstrated the use of gonadotropins alone resulted in no striking change in the seminal secretion. All of the gonadotropins were used and no appreciable difference in their efficacy was noted.

With reference to vitamin therapy, vitamin B_1, B complex and vitamin E were given in large dosage, alone and in combination with gonadotropic hormones. No significant effect was noted on the seminal secretions.

Where foci of infection were discovered, treatment was directed toward eradication of these foci. In many instances as the foci

of infection disappeared the seminal secretions improved.

In those cases in which there was an excessive number of sperm with an inordinate number of abnormal forms of the immature type, small doses of testosterone propionate (10 mg. twice a week) caused a decrease in the number of sperm with a corresponding decrease in the abnormal forms.

Epididymovasotomy was performed in a number of cases in which an obstructive factor was established. Our results were poor. No pregnancies resulted following this procedure. In our studies, therapy in general has been disappointing. It is probable that in many of these cases in which we are giving endocrine therapy the primary offending factor produces a secondary effect on the endocrine glands, the primary cause of sterility being overlooked. Further diagnostic procedures may bring to light these primary causative factors in sterility, the correction of which will improve our results.

COMMENT

We have computed in an impartial manner the results achieved in an active sterility clinic over a five-year period. In this communication the technical diagnostic approach and consideration of laboratory criteria have been stressed. The necessity for meticulous examination of spermatazoon morphology in every instance of suspected male infertility has been pointed out.

Testicular biopsy has been found a valuable diagnostic adjunct, but must be employed in conjunction with detailed seminal studies. As a test its most frequent failure occurs in those instances in which the total sperm count is normal but an inordinately high percentage of abnormal forms are present.

Of the entire series reviewed, pregnancy ultimately resulted in 11 per cent, this bearing testimony to the relative inefficacy of our present therapeutic methods. We agree with Meaker and Vose in their contention that constitutional deficiencies, such as chronic intoxications, malnutrition, and debilitating illnesses are potent factors responsible for infertility.

Our experience with a variety of hormonal stimulative therapeutic agencies has been disappointing. Where hypofunction of associated endocrines is revealed, as by basal metabolic rates and sugar tolerance tests, the deficiency must be overcome. Greatest success has been achieved in those cases in which thyroid dysfunction was proved. Kreutzman[8] states that only in cases of hypothyroidism has he obtained consistently good results. To stimulate spermatogenesis we have employed gonadogen, anteron, synapoidin, A.P.L. and antuitrin S. and have been unable to define significant differences in their value. On occasion, corticosterone has been employed as adjunct therapy. In those cases in which excessive numbers of unripe sperm exhibit excessive pituitary stimulation, testosterone in small doses may be indicated. In other cases degeneration of seminiferous elements of the testicle occurs with ultimate complete destruction if sufficient quantity is administered.

Because of repeated differential seminal analyses made during progression of treatment and employing a standard chart of abnormal forms, progressive alteration in sperm morphology has been observed. We have noted change following a definite direction. Where initially there is a preponderance of degenerate forms, change in these occurs, with improvement, to the immature and overripe spermatazoon until finally the greatest percentage show age changes rather than degenerative ones. We have labelled this phenomenon "shift to the left" because of directional change on our chart.

CONCLUSIONS

1. Analysis is made of 135 sterile marriages in which the male has been examined in our clinic.

2. Classification has been established on the basis of semen examinations.

3. The necessity is stressed for comprehensive appraisal of all factors to evaluate properly the status of the patient for there is no necessary relationship between motility, morphology, and sperm count.

4. Relationship between semen analyses and testicular biopsy has been considered. There is ordinarily striking correlation between these; exception occurs when total sperm count is normal but a high percentage of abnormal forms is present. Biopsy studies afford valuable diagnostic and prognostic aid.

5. Regeneration of testicular tissue in complete azoospermia with the final production of sperm able to induce conception has been demonstrated to be an uncommon but distinct possibility.

6. With progressive improvement in spermatogenesis changes are noted in the type of abnormal form in a definite direction from degenerative to the type of abnormal sperm most often seen in a normal specimen.

7. Endocrine therapy plays a limited rôle in most cases of male sterility.

8. A simplified technic for staining spermatozoa has been described.

We wish to acknowledge our gratitude to Doctor Clarence G. Bandler, Director of the Department of Urology, New York Post-Graduate Medical School and Hospital for his assistance and guidance.

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INTERNAL FIXATION FOR LUMBOSACRAL FUSION*

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DURING the third of a century which has passed since Hibbs first described the spinal fusion operation, its field of usefulness has been widely extended. Recently the number of patients operated upon for removal of displaced intervertebral disc substance has increased tremendously and it has become apparent that some of these patients should have spinal fusions done at the same time. Unfortunately, the prolonged bed rest in plaster has always been a serious objection to the operation and has deterred many people from it. It is not my purpose in this brief paper to attempt to define the various indications for the lumbosacral fusion operation, but rather to describe an operative technic for fusing the lumbar and lumbosacral regions which furnishes immediate rigid internal fixation, thus eliminating the necessity for external fixation and prolonged bed rest.

OPERATIVE TECHNIC FOR LUMBOSACRAL FUSION

The patient is placed prone on a hinged table and the lumbar lordosis partly obliterated by lowering both the head and foot ends of the table. The midline incision extends well down over the sacrum so that the muscles can be detached from its dorsal surface as far laterally as the posterior sacral foraminae. With a sharp elevator the muscles and ligaments are quickly and completely cleared from the fifth lumbar spinous process and laminae, and partially elevated from the fourth. This latter is necessary to get good exposure of the fifth. Interspinous, supraspinous ligaments, and all other soft tissues are carefully removed from the area to be fused. The lateral articulations are exposed by dissecting and scraping away their posterior capsular covers and their joint spaces opened slightly by strong traction with bone hooks under the laminae. As much as possible of their articular cartilages is removed and then a flat, thin, flexible cautery tip is inserted into the joint and the remaining cartilage cauterized. The fifth lumbar spinous process is removed and put aside for use as graft material at the close of the operation. The sharp edge of the small osteotome, or a small gouge can be used to make a notch in the middle of the cortical surface of the inferior articular facet of the fifth lumbar vertebra for the reception of the tip of a No. 31 drill. This is necessary to prevent "wandering" of the drill point when it begins to rotate. If the drill is directed downward and outward parallel to the inferior edge of the fifth lamina (Fig. 1), the resulting tunnel will pass through the middle of the two facets that make up the joint and on into the lateral mass of the sacrum. (Fig. 2.) A vitallium screw† is placed in the tunnel, tightened, and the same procedure carried out on the other side. Rigid lumbosacral fixation can be demonstrated by seizing the stump of the fifth lumbar spinous process with a heavy Kocher hemostat and lifting toward the ceiling.

The remainder of the operation consists in elevating multiple small bone chips from the fifth laminae and the dorsal surface of the sacrum. Supplemental bone grafts from the ilium or tibia are always used by the author, ilial bone being preferred. In an occasional case in which the spinous proc-

† For women and small men three-fourth inch long; for large men one inch long.

* From Department of Bone and Joint Surgery, Stanford University Medical School.

esses are well developed a tibial graft has been fastened directly on top of their stumps (Fig. 1) with short vitallium screws. After closure several drain pads are snugly strapped over the wound with adhesive, but no brace or cast is used.

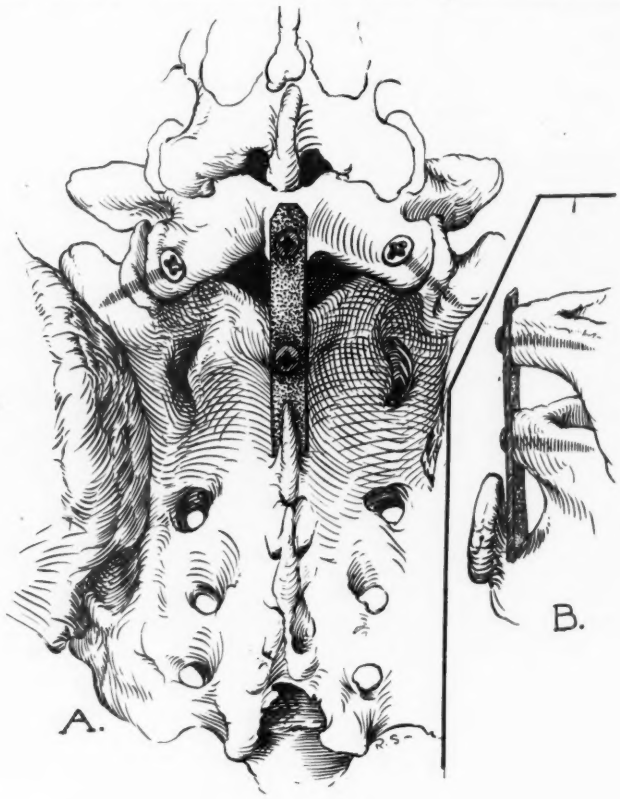


FIG. 1.

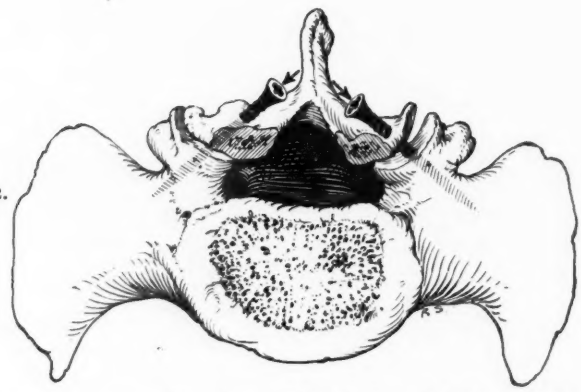


FIG. 2.

FIG. 1. A, posterior view of lumbosacral joint showing screws through lateral articulations and tibial graft screwed to spinous processes. Multiple chip grafts are not shown. B, lateral view showing tibial graft.
FIG. 2. Sacrum and arch of fifth lumbar vertebra (from above) illustrating direction of screws.

POSTOPERATIVE CARE

The patients are allowed to move about at will. Since internal fixation is rigid the amount of pain is definitely less and this, coupled with the absence of a cast, diminishes the opiate-distention cycle. Many of the patients are up and about in ten days but the average is about three weeks.

COMPLICATIONS EXPECTED AND REALIZED

We expected to see an occasional postoperative facet fracture originating in the screw hole. Actually, we have not as yet

been able to demonstrate this complication. In one patient there was persistent burning pain in the distribution of the fifth lumbar nerve root on one side, necessitating the removal of the screw. In a series of thirty fusions we have had one postoperative infection. The screws and grafts were removed during the second postoperative week.

Fig. 3. Case 1. *X*-rays taken fourteen months after operation. Top right shows excellent posterior bony bridge. Bottom left and right are oblique (sixty degree) views to show lateral articulations.

DISSECTING ROOM EXPERIMENT

In order to test the strength of the facets and rigidity of the fixation the operation has been done on fresh cadavers. With the cadaver in the prone position a hook was placed under the fifth neural arch and upward traction made with a rope passing over a ceiling pulley. It was found that small and medium sized cadavers could be raised from the table without the fixation giving way. In one very heavy cadaver, just as the trunk cleared the top of the table, with legs and arms still touching, the laminae fractured on either side of the hook under the spinous process. In another heavy cadaver the arch gave way bilaterally at the screw holes.

CASE REPORTS

Case 1. The operation was performed June 10, 1942. A. B., a female, age thirty-five, had had low backache off and on following an

automobile accident twelve years ago, in which her spine was "wrenched." During the past four years the back had bothered her constantly and she had had several attacks of sciatica on the right side. She had used fracture boards in her bed, manipulative treatments by chiropractors, and osteopaths, had worn surgical corsets, a lumbosacral brace, and a lumbosacral plaster cast. This last form of treatment gave considerable temporary relief.

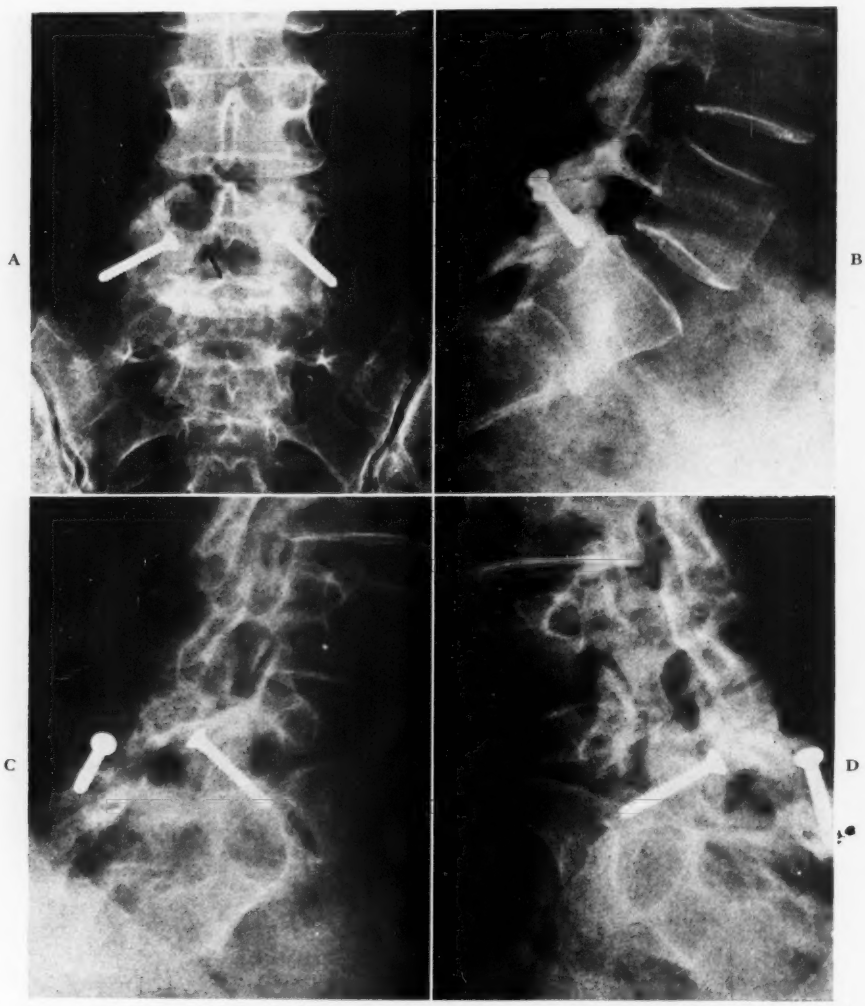


FIG. 4. Case II. *X*-rays taken one year after operation. Top left: anteroposterior arrow marks site of laminectomy. Two lower films are left and right oblique views (sixty degrees) to show the lateral articulations. Note complete disappearance of joint spaces.

Examination showed a flat lumbar spine with muscle spasm, tenderness over the lumbosacral region, a positive straight leg raising sign and a slightly weak knee jerk on the right. There was no history of rheumatism, and the sedimentation test was normal.

X-ray studies (Fig. 3) showed some thinning of the intervertebral disc between the third and fourth lumbar spinous processes.

At operation the neurosurgeon did a right laminectomy on the third lumbar and so damaged the lateral articulation that a screw could not be placed on that side. However, as indicated in the *x*-rays, screws were used in the articulation on the left side and in the lateral articulations between the fourth and fifth lumbar vertebrae, and between the fifth lumbar and first sacral, reinforced by bone grafts from the tibia.

She remained in bed four weeks, no postoperative support being used. At the present time she has an excellent fusion, the backache has disappeared but she still has some aching

pain in the right sciatic distribution if she is on her feet for a long time.

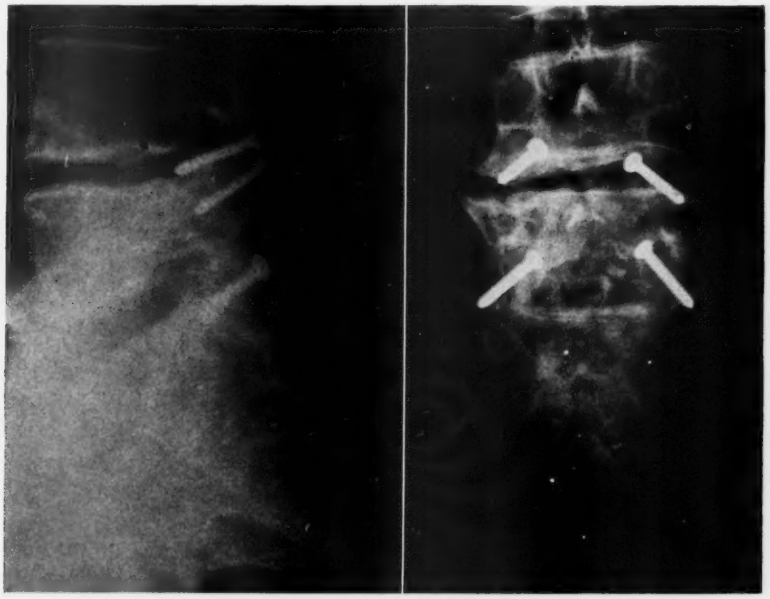
Case II. A. C., a twenty-six year old nurse, suffered from right-sided sciatica for one year before admission. Her neurosurgeon thought she had a posterior herniation of the fourth lumbar intervertebral disc but on doing a laminectomy (September 6, 1942) found nothing. The author was called to the operating room, and after reviewing the *x*-rays, which showed some degenerative arthritis in the lateral articulations, scrubbed up and placed the screws as shown in Figure 5. No grafts were used.

There was immediate relief of the sciatic pain. She remained in bed three weeks, returning to work eight weeks after becoming ambulatory. No postoperative support was used. She has remained well.

X-rays (Fig. 5) one year after the operation reveal bony fusion of the lateral articulations.

Case III. I. J., a thirty-seven year old female secretary, entered Stanford University Hospital March 6, 1942, complaining of chronic backache. This had bothered her off and on for at least fifteen years. There was an insidious onset without trauma. During the year preceding her entry she had almost constant left sciatic pain.

Examination disclosed a stiff lumbar spine, moderate atrophy of the left lower extremity, absence of the left Achilles reflex, and definite weakness of the peroneal muscles.



A B

Fig. 5. Case III. Anteroposterior lateral *x*-rays one and one-half years postoperatively.

X-ray studies revealed some loss of the fourth lumbar intervertebral disc with degenerative arthritic changes.

Operation was done on March 8, 1942. Laminectomies at the fourth and fifth discs failed to disclose a posterior herniation. A fusion of the fourth and fifth laminae to the sacrum was carried out, using the technic described. No postoperative fixation was used and she remained in bed four weeks.

When last seen, September 19, 1943, she was well, having returned to work three months after the operation. The Achilles reflex was still missing. (Fig. 5.)

SUMMARY

Rigid fixation of the lumbar joints can be secured by placing screws through the lateral articulations. The technic is described. Bone grafting, in the usual way, can supplement this fixation. No prolonged bed rest, cast, or brace is necessary. *X*-rays of three cases are shown to illustrate the technic.

SCLEROTHERAPY OF VARICOSE VEINS

UTILIZATION OF AN INTRAVENOUS AIR BLOCK

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THE treatment of varicose veins by injection with sclerosing agents, especially when preceded by high ligation of the saphenous veins, is an effective and time-tested therapy, supplanting the older radical operations of Schede, Mayo, Rindfleisch or Babcock.

The advantages of sclerotherapy are low morbidity, almost no mortality and no necessity for hospitalization, therefore, avoiding loss of working time. The mortality amounts to about 0.007—0.3 per cent (Westerborn, Ochsner, McPheeters).

The disadvantage is the very high incidence of recurrence. Ochsner, Howard, Jackson and Mahon estimate recurrence as high as 60 and 79 per cent. This high percentage, however, can be considerably reduced by combining the sclerotherapy with surgical procedures such as high ligation (Trendelenburg, Moschkowitz), retrograde injection of sclerosing agents, as introduced first by Unger and later repeated by Pratt, multiple ligations in the region of the venae perforantes, and extirpation of excessive large varicosities (Madelung operation). This combined method reduces the percentage of recurrence as low as from 10 to 16 per cent (Ochsner, McPheeters, Sarma) which compares favorably with the percentage of recurrences following radical operative methods of Babcock, etc., (18 to 20 per cent; Ochsner, and McPheeters).

The mortality of the radical surgical methods is high (1 per cent; Mueller and Ochsner) and can be reduced by using the combined method (0.4 per cent Kilbourne). It should be possible to reduce the mortality even more by proper selection of the cases, by keeping the operative measure as minimal as possible, and by keeping the patient ambulant.

The aim of sclerotherapy is to bring about a necrosis of the endothelium of the vein, leading to the formation of a chemical red thrombus which firmly adheres to the venous wall.

In order to bring the sclerosing agent in direct contact with the endothelium, the vein should be freed from blood before the solution is injected.

The simplest and, therefore, the best method, is the following: With the patient lying on the table, the legs hanging down, one tourniquet is applied above, and a second tourniquet below the vein section to be treated. After the needle is inserted, the leg must be raised from 45 to 90 degrees above the horizontal plane. The upper tourniquet is then released; after the vein is empty, it is re-applied, and the sclerosing agent injected into the vein.

This technic requires a certain amount of skill and at least one assistant. The syringe must be kept very steady, so as not to pierce the opposite veinwall. Once the vein is empty, the operator has no evidence whether his needle point is still inside the vein or not.

This method cannot be used in all instances, especially not where the lumen of the vein is small, or where the veins are only prominent with the patient in standing position. In these cases, the solution must be injected into the filled vein ("full vein technic"—P. Riddle), a procedure which very often is followed by failure.

In the course of twenty years' practice, the writer encountered numerous nonetakes with both methods, requiring repeated injections into the same vein

sectors. Although strong solutions, such as hypertonic sodium chloride or 10 per cent sodium morrhuate, were used, a satisfactory sclerosis could not be effected. These were veins which could not be emptied satisfactorily; some of them showed fibrotic, rigid non-collapsible walls, others were found to be at the dorsum pedis, and near the malleoli and others were thought to be in the vicinity of the rami perforantes.

In searching for a more effective and easier applicable method, the author adopted the idea of introducing air into a closed vein sector, with the aim in mind of expelling the blood completely from a small portion of the blocked sector, following which the sclerosing agent is injected into this air-filled space.

A priori, it was conceded that the contact between the agent and the endothelium is of very short duration but sufficient to bring about instantaneous endothal-necrosis. Following this phase, the agent, diluted with blood, gradually exerts the same effect as is expected and obtained by the full vein technic.

To demonstrate the physics of induction of air into a tubular system, the following experiment was done (Fig. 1):

An intravenous set is filled with water, and the air removed from its tubing. In order to eliminate the negative pressure prevailing inside the system, the section of the tube in which the experiment takes place is clamped off bilaterally. The observation may easily be made by using a transparent tubing placed in front of an intensive light.

First Experiment. One cc. of tinted solution (eosin- or mercurochrome solution) is injected into the tubing. As soon as the liquid enters the tube it mixes readily with the water, forming a red column which gradually descends to the lowermost clamp, reaching it after forty-five seconds, and having covered 37 cm. of tubing. (Diameter of the lumen: 6 mm.)

Second Experiment. A syringe containing 1 cc. air and 1 cc. of mercurochrome

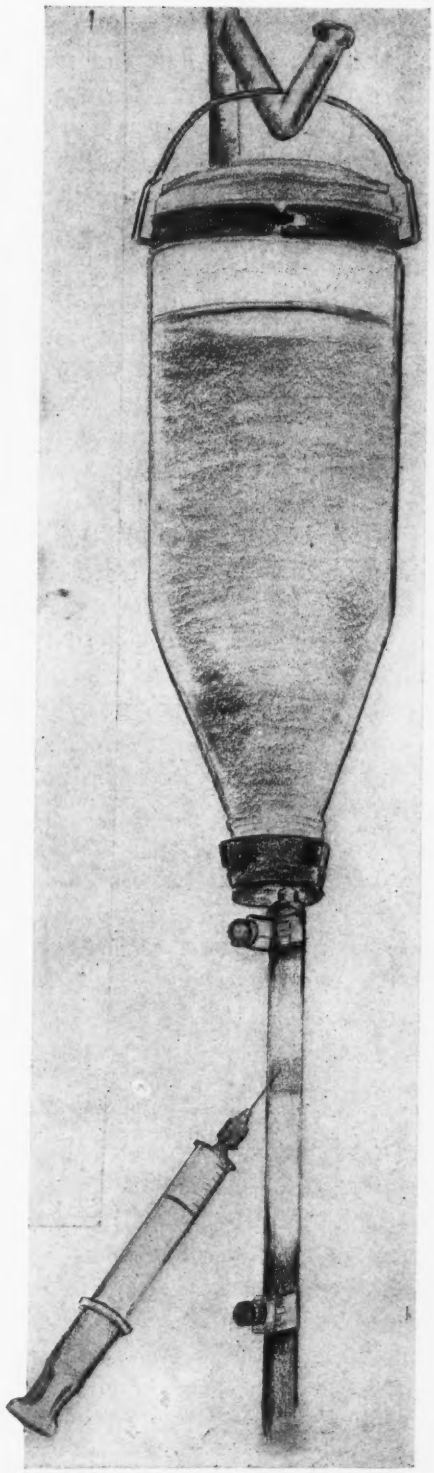

Fig. 1. A transparent and bilaterally clamped-off tubing of a water filled intravenous set is used for the experiment; 1 cc. of a tinted solution is injected into it. Then the injection is repeated after preceded injection of 1 cc. of air. The physical phenomena of both experiments, observed in front of a strong light, are described in the text.

solution is held with the needle upward and first the air, and then the mercurochrome is injected into the tubing. When the injection is done very slowly, individual air bubbles enter the water in the tube and rise toward the upper clamp. With a speedier injection, only a few individual air bubbles escape upward, and nearly all of the air in the syringe forms an air block, displacing the water. As soon as the mercurochrome enters this air space it descends to the lower level of the air block, where it mixes with the water. The injected solution does not fall through the air space, but is distributed along the wall of the tubing before accumulating at the bottom of the air section. There is a similarity between this phenomenon and the distribution of food inside the stomach, the meal using the route of the lesser curvature to reach the pylorus. With the injection done fast a layer of undiluted solution replaces a part of the air space for about three to five seconds. In about forty-two seconds all the water between the two clamps is tinted red—three seconds less than in the former experiment, due to higher intratubular pressure caused by the inflation of air. After completion of the experiment about 0.15 cc. of air can be recovered from the tubing.

Studies of venous pressures show that when patients with varicose veins are in the standing position, the saphenous pressure corresponds closely with the hydrostatic pressure (H. S. Mayerson, et al.), therefore, permitting the above experiment to be drawn into consideration as a comparative, easily demonstrable theoretical basis.

The technic of creating an intravenous air block is simple. With the patient standing or sitting, a tourniquet is applied above the vein to be treated. (In my latest series I omitted the tourniquet.) The syringe is held with the needle upward, so that air is above the level of the agent. After insertion of the needle into the vein, indicated by appearance of blood in the syringe, the air is injected and, with one continuous movement, the sclerosing solution.

The amount of air to be injected should equal the amount of the sclerosing agent, but should never exceed 3 cc. in amount.

After completion of the procedure, a piece of gauze is tightly applied to the site of the injection, and kept in place with adhesive tape, and finally, the leg is supported by an elastic bandage.

In injecting superficial and transparent veins, it can be clearly seen how the entering air expels the blood from the vein, and how the solution replaces the air-filled space. In all such cases, an instantaneous formation of a chemical thrombus is noted.

For fear of air embolism, the first injections were done on such patients only who had high and multiple ligations; later on this method was employed on patients who had not had previous ligation. In a series of 297 cases, no air embolism has occurred. There was only one incident, which, prima vista, appeared to be caused by air embolism, but later on proved to be an acute quinine poisoning.

A sixty-four year old man with excessive superficial ulcerations on both lower legs and third degree varicose veins, refused surgical intervention. He received eighteen injections of 5 per cent sodium morrhuate, ranging from 1 to 2 cc. for each vein sector. The last three injections were done with the air block. They were tolerated with no untoward effects. At the fourth injection, for which quinine urethane was used, the patient experienced heat sensation in his head, his face became flushed, he became slightly irrational and disoriented. There was no change in temperature, pulse or blood pressure and no respiratory embarrassment. After one hour the patient was able to reach his home by taxi.

These symptoms do not resemble those of air embolism, in which one finds cyanosis, dyspnea, shock, slow pulse, convulsions (G. R. Osborn et al., H. M. Wyrauch, Pompe, McDaniel, Chase). A diagnosis of acute quinine poisoning was

made and confirmed a few days later when the patient appeared with a typical quinine rash.

Introduction of air, in small amounts, into the venous system, does not lead to clinical air embolism. It appears that air in small amounts does not reach the pulmonic circulation, being entirely absorbed on its way centrally.

According to H. F. Richardson, B. C. Colles, G. E. Hall, J. B. Wolffe, and H. F. Robertson, 480 cc. of air entering the venous system within twenty to thirty seconds will cause death in a person weighing 60 kilograms. The writer was unable to find in the literature any instance of fatalities when air entered the saphenous vein or its tributories.

Lethal embolism was reported when air entered the thorax (Borack and Wilder), the knee (insufflation), the bladder (after diagnostic insufflation—Jockisch), the uterus (pregnancy, abortion—H. H. W. Petri), the perirenal space (insufflation for *x*-ray diagnosis *Weyrauch*), the elbow vein (Pompe), and the cervical veins (Larson et al., K. Neller).

The therapeutic effects with the described method are very satisfactory. The percentage of takes is considerably higher than with the conventional methods. In some cases, the phlebitic reactions seem to be slightly more pronounced. However, this can be successfully counteracted by application of supporting and compressing bandages, and by the use of external heat.

The described method should not be used for the sclerotherapy of large varicose veins. Here the conventional method has its place. Medium and small veins for which usually the "full vein" method is employed, are the field of the described technic.

Two safe-guards may be mentioned: (1) For each injection a new sharp needle, No. 22 gauge and up, should be used. (2) Never should a vein be injected which is not readily accessible. If, after the initial thrust of the needle, blood does not appear in the syringe, a different site should be chosen.

SUMMARY

1. Conservative surgery and sclerotherapy give satisfactory results in the treatment of varicose veins, with short or no hospitalization, low morbidity, and very low mortality.

2. Injection of a small amount of air into a varicose vein prior to injection of the sclerosing agent, expels the blood out of the vein sector, and allows the sclerosing solution to act upon the endothelium undiluted, producing a firm chemical thrombus.

3. The theoretical basis of the air-block method is discussed.

4. The air-block method does not replace the conventional methods. It supplements them, and should be used only for medium and small veins.

5. There is no danger of air embolism with introduction of small amounts of air into the superficial veins of the legs.

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Urology Award.—The American Urological Association offers an annual award "not to exceed $500" for an essay (or essays) on the result of some specific clinical or laboratory research in Urology. The amount of the prize is based on the merits of the work presented, and if the Committee on Scientific Research deem none of the offerings worthy, no award will be made. Competitors shall be limited to residents in urology in recognized hospitals and to urologists who have been in such specific practice for not more than five years. All interested should write the Secretary, for full particulars.

The selected essay (or essays) will appear on the program of the forthcoming June meeting of the American Urological Association.

Essays must be in the hands of the Secretary, Dr. Thomas D. Moore, 899 Madison Avenue, Memphis, Tennessee, on or before March 15, 1945.

PITFALLS TO BE AVOIDED IN CHOLECYSTECTOMY

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THE progress made in the surgery of the gallbladder has been one of the great triumphs of operative therapy, and the story of this advance is a fascinating one. A discussion on problems in cholecystectomy would therefore seem presumptuous. And the writer would not consider submitting this paper were it not for the fact that the anatomical and technical pitfalls are still not fully appreciated. Too many common ducts are still being cut during cholecystectomy.[1,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39]

Technically, gallbladder surgery is the most difficult and dangerous of any abdominal surgery, and an inadequate appreciation of the variations and abnormalities of this region is responsible for increased mortality and morbidity. The development of improved surgical technic, improvement in preoperative preparation, anesthesia and postoperative management have been important factors in reducing the mortality. In the past fifty years the mortality from operations on the biliary tract have been reduced from 16 per cent (Courvoisier, 1889[23]) to 3 per cent or less (Berkson[24]). However, in the hands of those not especially trained mortality still rises to 10 per cent or even higher.[3] Mortality advances rapidly with age. The mortality is greater in males than in females.[3] Morbidity from bile duct injuries usually go unreported, and hence any estimate of this incidence would be inaccurate. The sequelae of accidental division or excision of a segment of the duct or its inclusion in a ligature during cholecystectomy are such that irrespective of surgical repair of the injury the end results are usually poor. Bakes[4] observed bile issuing from the wound 230 times in 246 cases of simple cholecystectomy—an indication of either a severed accessory bile duct or injury to the bile duct apparatus. Injury to the bile ducts continues to be one of the most significant operative complications. Hence many surgeons have justly stressed among the pertinent factors in reducing mortality and morbidity in cholecystectomy, an intimate knowledge of the common and special anatomy of the bile duct apparatus.[5,13]

These are the days of frequent cholecystectomy, the operation most commonly performed on the biliary tract. Outside of the appendix the gallbladder more often calls for operative treatment than any other intra-abdominal viscus. But if we may judge from the great number of patients unrelieved or requiring a second operation, or the number of strictures of the common duct which occur, there would seem to be room for improvement. Though quite a large number of injuries to the bile ducts have been reported by various authorities, notably Eisendrath,[17] Elliot,[18] Lahey and Walters,[11] these probably represent only a small fraction of the total number, for surgeons do not feel disposed to advertise their errors. That the incidence of duct injury is higher than the inadequate statistics would indicate, is borne out by the numerous reports of methods of reconstruction of bile ducts injured during cholecystectomy. A book by Hargan[6] on the methods of reconstruction of the biliary tract further serves to emphasize the frequency of severe injuries and their great significance. More recently Pearse[7,16] has described the use of vitallium tubes for repair of injured bile ducts and states that common duct strictures are traumatic in origin and are the direct result of cholecystectomy in from 80 to 90 per

cent of the cases. With the increased number of cholecystectomies, complicated surgery of the bile ducts has multiplied.

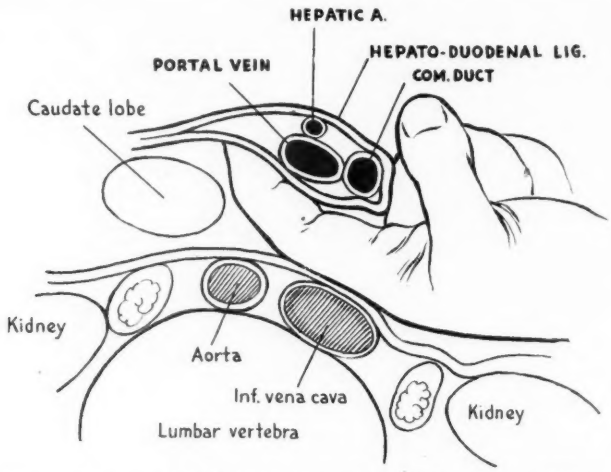


FIG. 1. Shows the left index finger in the foramen of Winslow. Note the common duct, hepatic artery and portal vein in the hapatoduodenal ligament. Raising the ligament interrupts the blood supply to the liver. The hepatic artery may be compressed here for the control of hemorrhage from a torn or slipped cystic artery during cholecystectomy. Related structures in this vicinity are illustrated.

What are the reasons for these anatomical and technical difficulties in cholecystectomy? The anatomy in the region of the gallbladder makes good exposure difficult. The bony framework of the lower wall and the bulk and immobility of the liver, plus its peculiar shape all help to obscure the operative field. The close proximity of the stomach and colon add to the surgeons difficulties. Maintenance of adequate exposure is trying because the structures are in a dark deep hole, the sides of which are kept in constant motion by the diaphragm. Another source of considerable difficulty is the deep situation of all structures under the liver. The structures are short and the right lobe of the liver hides the hepatic and cystic ducts. Add to this a fat patient taut and heaving from insufficient anesthetization and safe cholecystectomy may well nigh be impossible.

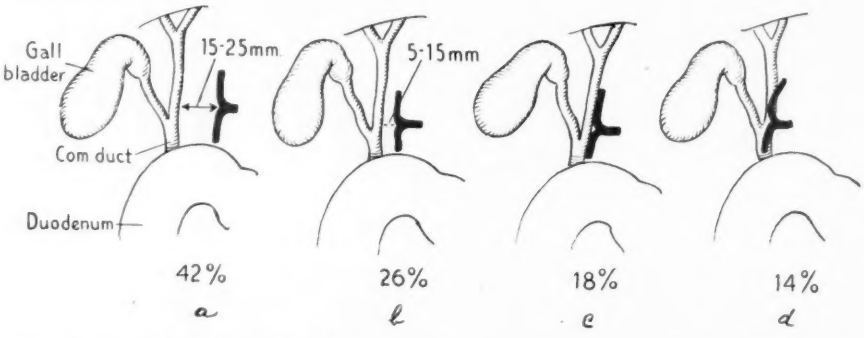
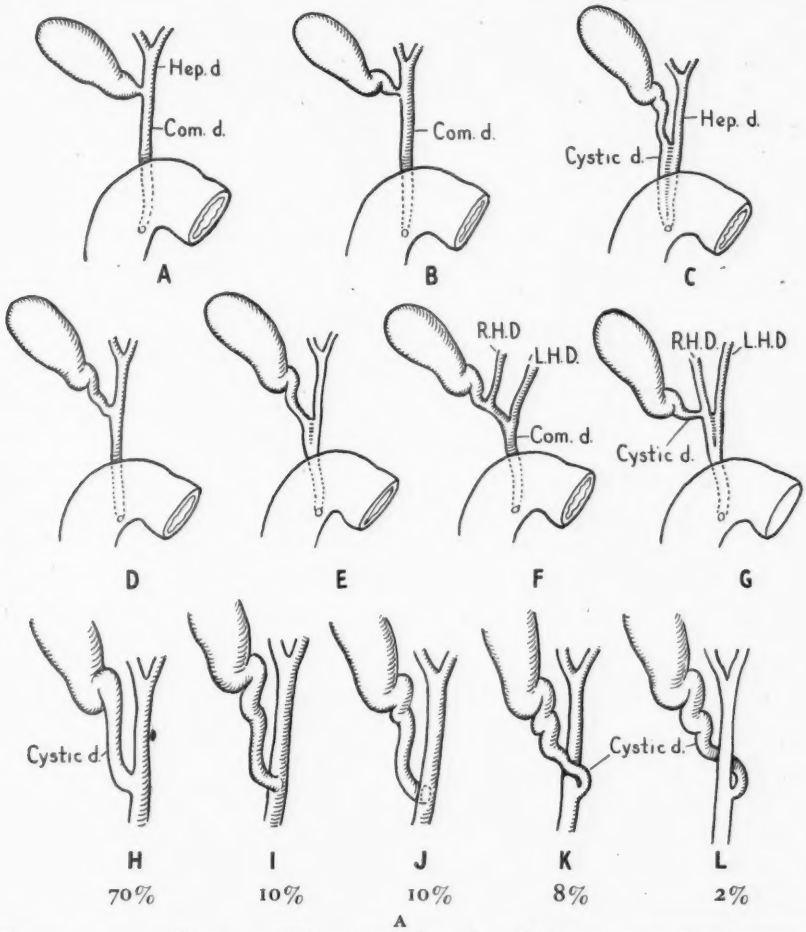


FIG. 2. Shows a relationship of the hepatic artery to the common duct. Figure *d* illustrates a particularly dangerous situation present in 14 per cent of cases according to Rio Bronco when the hepatic artery overlies the common duct. This relationship should be kept in mind during choledocotomy, and the hepatic artery sought for and displaced before incising the duct.[43]

When the above handicaps have been surmounted, the factor of variations and anomalies enter and these are of the utmost importance, since every possible variation

can become an actuality. The occurrence of these variations receive either no mention at all or only a brief one in most all of the main hepatic and the cystic duct. (Fig. 2.) We have been taught and still are taught that the cystic artery is a single

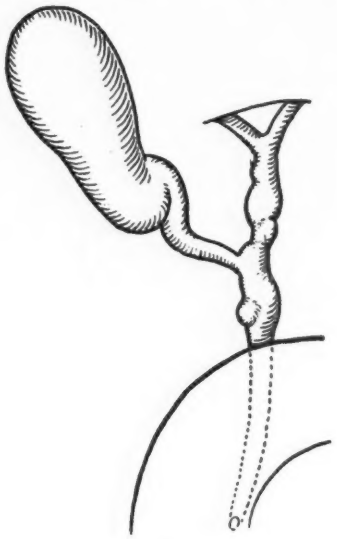


A

Fig. 3. A, A to E illustrate different relationships of the cystic to the common hepatic duct. The relationship illustrated in C occurs in 24 per cent of cases according to Descamp. This is surgically important. F illustrates an anomaly of the right hepatic duct. G illustrates the cystic duct terminating in the right hepatic duct. H to L illustrate various modes of entry of the cystic into the common hepatic duct and the approximate incidence according to Descamp.[21] K and L illustrate the anterior and posterior spiral modes of entry of the cystic into the common hepatic. The presence of a stone in the cystic duct in K and L could produce clinically the same symptoms as that of common duct obstruction. The removal of a stone from the cystic duct in either K or L could easily result in injury to the common duct unless this anatomical relationship is kept in mind. The spiral mode of entry occurs in 8 per cent of cases according to Descamp and 37 per cent of cases according to Rugi.

of our standard textbooks of anatomy and operative surgery. The anatomical teaching is, that there are two bile ducts one from each lobe which join close to the liver to form the hepatic duct, and this is joined shortly by the cystic duct at an acute angle, and that the common duct is a single structure which is formed by the union vessel arising from the right hepatic, shortly after the latter passes behind the main hepatic duct. The common duct is described as being sufficiently devoid of large blood vessels on the anterior surface of its supraduodenal portion to permit of easy access to an incision in this portion, as the best approach in the removal of

stones from the common duct. If the above teachings were correct, we would not encounter any special technical difficulties.



B

FIG. 3. B, a drawing of the author's dissection showing herniations or parietal sacculi in the wall of the common duct. These outpouchings usually contain no muscle fibers and consist of mucous membrane and adventitia. They are easily torn or ruptured.

There would be fewer injuries to the hepatic and common duct with fewer strictures of the common duct. The right hepatic artery has been damaged and ligated with resulting progressive hypoglycemia and death,[8] and accidental division of the common bile duct has occurred during cholecystectomy by experienced surgeons.[9] In a review of forty-seven cases of strictures of the common duct, Judd noted that all but five followed some type of operation on the gallbladder or ducts. No less an authority than Doctor Lahey states that practically all strictures of the common and hepatic ducts are man-made strictures.[10] In support of this contention it may not be amiss to relate an incident which occurred in the practice of one of the most skillful and experienced surgeons in the country. He had completed a cholecystectomy and closed the operative wound. He was about to leave the operating floor when he bethought himself to examine the specimen. To his consternation he found a portion of the main duct attached to it. A second operation was done with a very happy result. If such a thing can happen to one of our great surgeons, how much more likely is it to occur in the work of the average surgeon. This serves to illustrate the necessity of careful examination by the surgeon of the specimen immediately after cholecystectomy. Delayed operations for the repair or reconstruction of bile ducts are extremely difficult and must often be performed on deeply jaundiced and otherwise

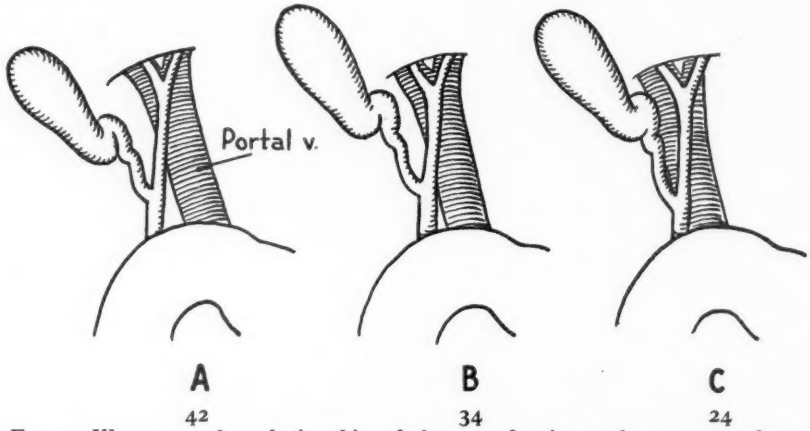


FIG. 4. Illustrates the relationship of the portal vein to the common duct. The relationship is especially close in 24 per cent of cases as illustrated in C; and injury to the portal vein can occur if the common duct is not opened carefully or during repair of a strictured common duct. Kehr and Lahey report injury to the portal vein during operative procedures in this region.

incapacitated patients. The mortality is, therefore, high. Those who recover, frequently after multiple operations, are doomed to ill health, recurrent fever, chills and jaundice.

To avoid errors in operative technic a thorough familiarity with every possible variation in the biliary tract is mandatory, for prevention of injury is of paramount importance. And prevention may be facilitated only through the possession of an intimate knowledge of the variations of ductal and vascular structures. While human beings are singularly alike in their general anatomical construction, yet when one comes to investigate any particular region with more detail, it is surprising how frequently we meet with variations of one sort or another. More especially does this apply to the vascular system and in no region more than in the liver. This I think is generally appreciated by anatomists. My professor of anatomy, the late Doctor Stockhard, of Cornell used to say that if we all had a transparent abdominal wall, we would know each other by the appearance of our viscera, so great are the variations of the normal. Flint[13] after 200 dissections of the gallbladder and ducts found only sixty-nine cases of so-called normal. He states that the variations are so frequent that it is impossible to regard any one type as normal. Anatomical studies by Ruge,[19] Kurz[20] Descamp,[21] Behrend,[22] and Eisendrath[17] have shown for example that there are two cystic arteries in 12 per cent of individuals, a fact generally not appreciated by most surgeons. Descamp[21] believes that 18 per cent is more accurate. At any rate it occurs often enough to put the surgeon on his guard when he has ligated only one cystic artery. (Fig. 6.) To anticipate any normal arrangement of the bile structures is to invite disaster. The writer has therefore summarized the more important variations and anomalies of the bile ducts and the related blood vessels with which every surgeon should be familiar. These anatomical variations may further be distorted by pathological changes. This multiplicity of variations and anomalies, further multiplied by the pathological distortions

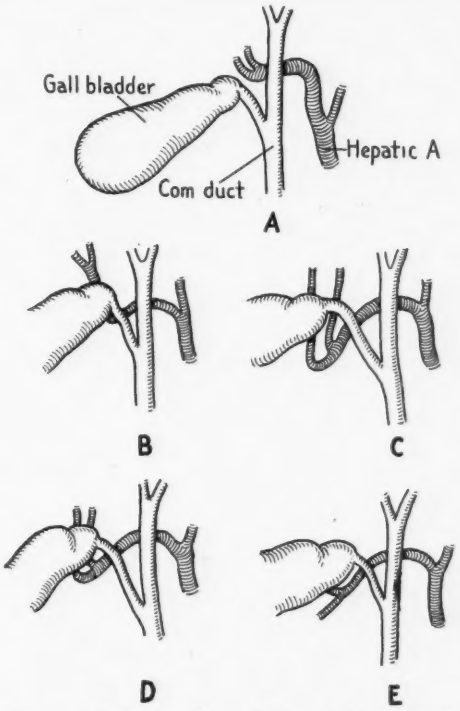


Fig. 5. Relationship of the right hepatic artery to the cystic duct and neck of the gallbladder according to Rio Bronco. A and B represent the usual relationship; C and D a rather frequent occurrence; E a rare relationship. These figures illustrate Calot's triangle with the right hepatic artery as the northern boundary rather than the cystic artery. Ligation of the right hepatic artery in this location for the cystic artery results in hypoglycemic shock and death.[23,43,45]

indicates the serious problems which frequently confront the surgeon during cholecystectomy.

Variations in the bile ducts and in the cystic artery are the more frequent causes of accidental injury to the ducts during cholecystectomy. (Figs. 3 and 6.) Though the gallbladder and the cystic duct are the ready guides to the common duct, it should not be forgotten that the cystic duct is not at the bottom of the gallbladder, but to its inner side, and that the pelvis of the gallbladder may overlap the cystic duct and cover the preduodenal common duct. (Fig. 8F.) The cystic duct varies in size as shown by recent studies.[11] In

55 per cent of cases the duct is believed to be from 2 to 4 cm. long; in 25 per cent more than 4 cm. in length, and in 20 per cent less than 2 cm. in length. The circumference of the cystic duct varies, but it is smaller than the hepatic or common bile ducts. This small caliber of the cystic duct is of significance since many accidents of gall-bladder surgery occur about the cystic duct at its site of contact or union with the hepatic duct. Careful examination should, therefore, be carried out to determine the anatomic relation and it may be assumed that a large duct in this region is more probably not the cystic duct. This junction of the cystic, common and hepatic ducts is the important area. Moreover Calot's triangle is frequently completed by the right hepatic artery instead of the cystic as described by Calot. This variation may

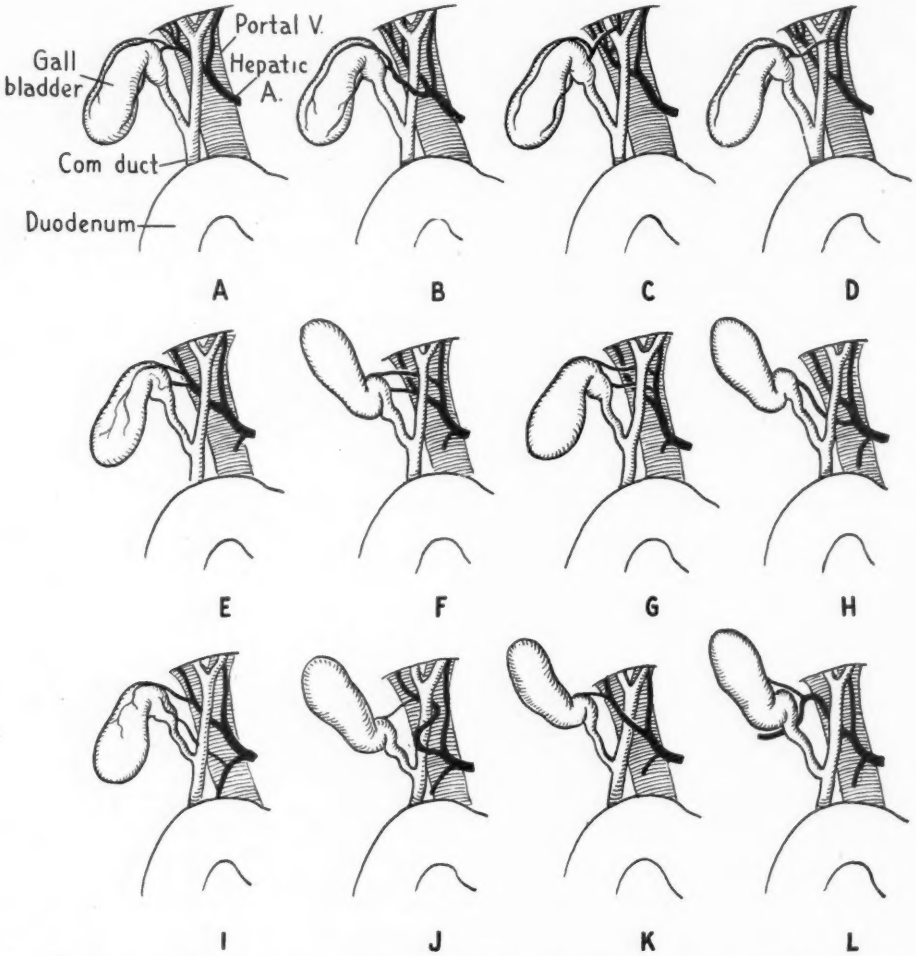


FIG. 6. Shows variations of the single and double cystic arteries. E, F, G, and I show the various types of double cystic arteries. The double cystic artery occurs in 12 to 18 per cent of cases. E shows both cystic arteries off the right hepatic artery. F shows one cystic artery from the right hepatic and one from the left. G shows two cystic arteries from the left hepatic. H shows the cystic artery coming directly from the common hepatic. I illustrates one cystic from the right hepatic and another from the gastroduodenal. The cystic artery may be branched or double. This often gives rise to hemorrhage after the cystic artery has been considered ligated. The cystic artery may be a branch of the pancreatoduodenal artery or even from the superior mesenteric artery.[45] The right hepatic artery may be tortuous and in close relation to the ducts. It may even cover the ducts as shown in Figure 2D and Figure 6J and L making all sorts of fantastic figures. The cystic duct is in close relation to the artery which may be injured during cholecystectomy.

result in ligation of the right hepatic artery for the cystic artery with resulting so-called "liver death." (Fig. 5A to E.) trol it accurately. Instead of this, he clamps wildly and picks up the hepatic duct in the clamp." Attempts to control bleeding

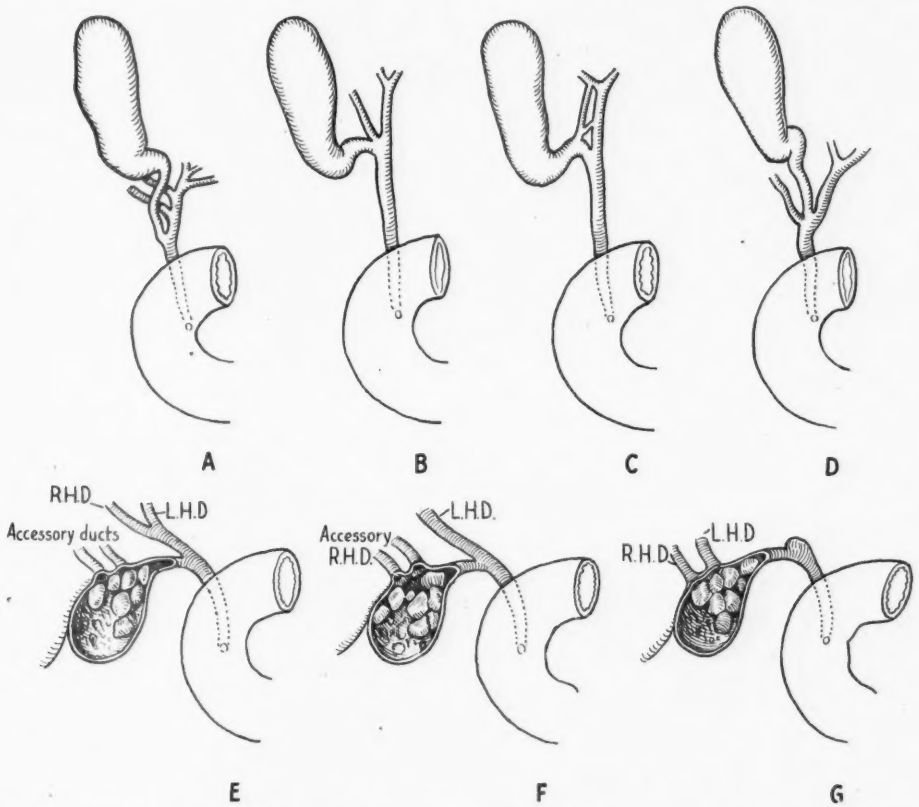
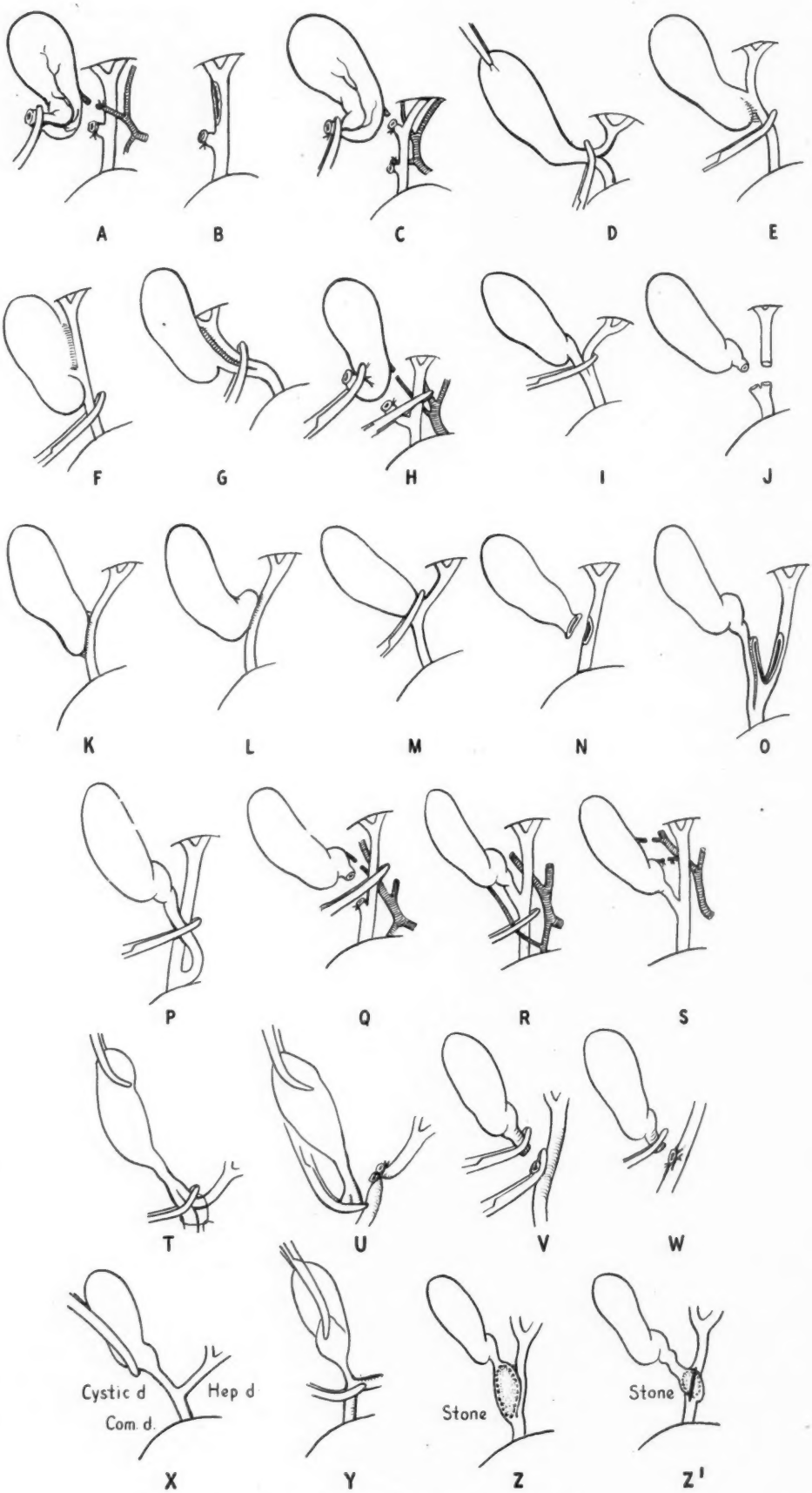


FIG. 7. A to E illustrate the various types of accessory bile ducts which are present in 20 per cent of cases.[43] Leakage of bile from a divided end may be a troublesome or even fatal complication. F shows the right hepatic entering the gallbladder directly and G shows both the right and left hepatic ducts entering the gallbladder. Cholecystectomy *from the cystic duct up* in F and G would result in a fatality, while attempted cholecystectomy *from the fundus down* would recognize this anomaly and cholecystostomy could be done.

No one with experience in biliary surgery will deny that this dangerous triangular region which complicates biliary surgery lies at the deepest, most inaccessible point of the operative field. Unexpected hemorrhage from the slipping of a clamp or a tie off the cystic artery in this area is frequently the beginning of a vicious circle. Lahey,[12] speaking of duct injuries says, "They are the result of excitement, I think, the cystic artery gets loose, bleeds into the deep operative field. The inexperienced operator fails to realize that by pinching the hepatic artery with his finger he can stop the bleeding artery, wipe the field dry, find the bleeding vessel, and control it accurately. Instead of this, he clamps wildly and picks up the hepatic duct in the clamp." Attempts to control bleeding in this area from a torn or cut cystic artery can produce injury not only to the bile ducts but also to the portal vein, duodenum and even the head of the pancreas.

What is the safest technic for cholecystectomy? There is still difference of opinion among surgeons as to whether the gallbladder should be removed by *starting at the fundus and dissecting downward*, or by *starting at the cystic duct and working upward*. Both methods have their protagonists, but which ever method is chosen, two main factors must be emphasized: (1) It is absolutely essential that a complete isolation of the cystic duct be made before any clamps or ligatures are applied.



(For descriptive legend see opposite page)

(2) The cystic artery and duct must be tied securely (either separately or together).

In cholecystectomy beginning at the cystic duct, the cystic artery and duct are ligated first, this makes cholecystectomy a cinch, for the circulation is controlled from the outset. However, identification and isolation of the cystic artery and duct is not always easy, because of the difficulties of exposure mentioned above and because of the great variations in the arrangement of the bile ducts and blood vessels. Besides the cystic artery does not always lie to the north of the cystic duct in vermillion color (as illustrated in textbooks of operative surgery) waiting to be ligated. More often

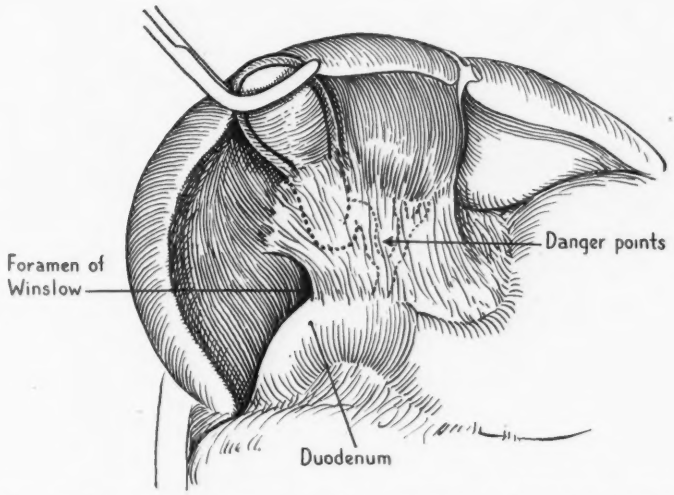


FIG. 9. Shows the method of cholecystectomy *from the fundus down*. Note the author's method of grasping the fundus so that the tips of the right angle clamp extend beyond the gallbladder. If the tips of the clamp terminate on the gallbladder, the wall of the gallbladder is soon perforated with tearing and leakage of bile. Note the foramen of Winslow and the danger points which are submerged and buried in adhesions. Cholecystectomy *from the cystic duct up* is more hazardous when the danger points are submerged and they usually are.

FIG. 8. Illustrates the various mechanisms of operative trauma from A to Z during the performance of cholecystectomy: A, shows ligature of right hepatic artery during the performance of cholecystectomy (after Maingot); B, shows button holing of the common duct (after Maingot); C, shows ligature of right hepatic duct during cholecystectomy (after Maingot); D, clamping of common duct during cholecystectomy (after Kehr); E, the common bile duct has been clamped in mistake for cystic duct. Hartman's pouch overhangs the duct and the gallbladder is adherent and sclerosed (Fig. 2); G, division of common hepatic duct with an adherent cystic duct (after Walton); H, duct and artery clamped by a hemostat following the slipping of the ligature which has been applied to the cystic artery (after Walton); I and J, resection of the junction of cystic and common ducts; K and L, tear or division of the main hepatic duct which might arise in separating the upper side of the pelvis of the gallbladder from the duct (after Thorek); M and N, shows what may happen during cholecystectomy by clamping when the cystic duct is very short. O, shows an injury which may result to the hepatic ducts when the cystic and hepatic ducts run parallel for a long course; P, injury which may arise to the hepatic duct when the cystic duct winds around in front of it; Q, injury resulting to the hepatic duct during effort to catch bleeding cystic artery; R, injury to the common duct during effort to catch anomalous bleeding cystic artery arising from the gastroduodenal; S, hemorrhage which may occur from overlooked second cystic artery; T and U, show semi-diagrammatically how a section of the common and hepatic ducts may be removed by applying the clamp too low after pulling up on the cystic duct (after Lahey) (Figs. 12 and 13); V and W, show diagrammatically how stricture of the duct can result from applying the clamp in cholecystectomy too low. X and Y, show how traction on the gallbladder during cholecystectomy will bring the cystic and common ducts into the same line. The surgeon may, therefore, mistake the common for the cystic and crush it by clamp or ligature (Fig. 15); Z and Z^1, illustrate how a stone in the cystic duct can occlude the common duct. Removal of such a stone from the cystic duct as illustrated in Z^1 can injure the underlying or overlying common duct, especially when the stone is located by palpation of the duct and the incision is made directly over the stone.

we encounter a lot of bleeding connecting tissue strands down deep in a dark hole. If the cystic duct which is isolated more readily than the artery is dissected and cut first, the vessel which is shorter than the duct may tear, retract and bleed freely. Attempts to catch this retracted vessel may lead to the injuries described above. Then again one cystic artery having been secured and ligated, a similar hemorrhage and retraction may occur from a second overlooked cystic artery which is inadvertently cut or torn. This can occur in 12 to 18 per cent of individuals and stampede the operator into efforts of blind control of hemorrhage with its hazards of bile duct injury.

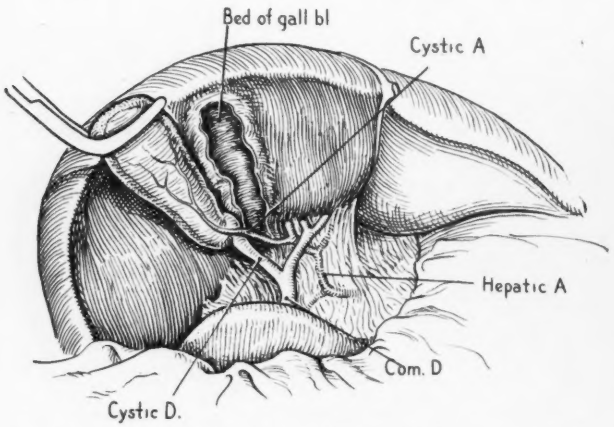


FIG. 10. Illustrates the further progress in removing the gallbladder *from the fundus down*. The gallbladder is stripped from its avascular cleavage plane in the liver bed leaving a margin of peritoneum with which to cover the raw surface of the liver. Traction on the fundus draws the gallbladder away from the liver bed until the cystic vessels and common duct are reached. In this manner considerable portions of the cystic duct are not left behind and variations of the blood vessels and ducts are more easily recognized. The cystic duct is delivered out of its depth, straightened out and ligated under better exposure and direct vision. (Fig. 10.)

The frequency of ductal and vascular variations in this triangular danger zone emphasizes the hazard of beginning the removal of the gallbladder in this area. Figure 5 shows how easy it is to mistake the right hepatic artery for the cystic and ligate or injure same. That this may occur, it may not be amiss again to relate an incident which the writer witnessed recently in the practice of one of the best surgeons in this country. Under spinal anesthesia, the gallbladder and ducts were exposed in a particularly dry, clean field. In plain view, what appeared to be the cystic artery was easily demonstrated, completing the boundary of Calot's triangle. A ligature was passed around this vessel but fortunately it was not divided since it later proved to be the right hepatic artery and not the cystic. Again, if this can happen to our great surgeons, how much more frequently can this occur in the work of the average surgeon; and most of the cholecystectomies today are performed by the average surgeon.

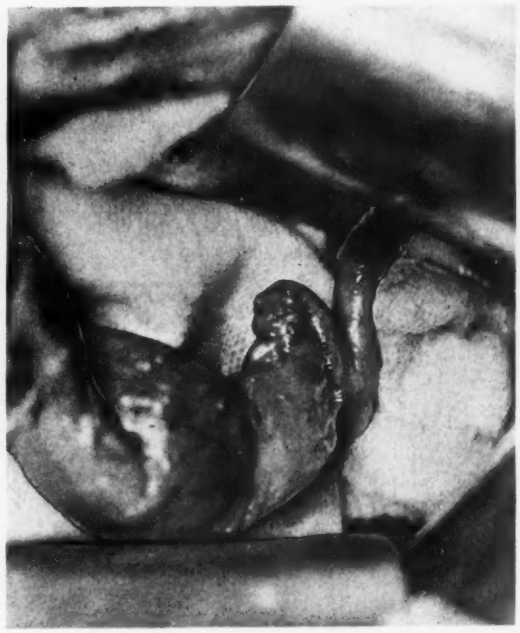


FIG. 11. Photo of the author's dissection showing Hartman's pouch overhanging the common duct with an adherent and sclerosed gallbladder.

An adequate incision, proper retraction and a good light are essential for proper exposure and the avoidance of complications. There are few operative fields where roughness and haste are more disastrous. Many technics and tricks have been devised and described toward obtaining good exposure for cholecystectomy. But a good anesthesist is still the best agent of all for the acquisition of a satisfactory

view of the parts concerned in the field of operation. "To see is to save" and anything which cannot be seen especially be certain of the anatomy. Hence the most expert surgeons have been led into entrapments at the triangle which have

Fig. 12. Fig. 13. Fig. 14.

Fig. 12. Photo of author's dissection showing how traction on the cystic duct can produce angulation of the common duct.

Fig. 13. Photo of author's dissection showing the mechanism of injury of the common and hepatic ducts by applying the clamp too low after pulling up on the cystic duct.

Fig. 14. Photo of author's dissection showing how stricture of the duct can result from applying the clamp too far down on the cystic duct during cholecystectomy. Part of the wall of the common duct is ligated producing a stricture.

when it is in the operative field is in danger of injury. It seems to me that no one in the light of present information ought to perform cholecystectomy without a thorough knowledge of the parts in the region of the foramen of Winslow. (Fig. 1.) The first step should be to examine the gallbladder and bile ducts and it is good practice to observe the condition of the pancreas at the same time. We are apt, when disease of the gallbladder is manifest, to forget to examine the ducts until a later period of operation, and in consequence we may find ourselves at a disadvantage.

The actual method of removing the gallbladder whether *from the fundus downward* or *from the cystic duct upward* has been a subject of discussion for years. Surgeons beginning at the cystic duct argue that their method is easier since the circulation is controlled at the outset, and in this manner the most difficult part of the operation is accomplished first. However, even with perfect exposure, under spinal anesthesia, one cannot always

led to unhappy experiences. In many instances the neck of the gallbladder and cystic duct are submerged in dense adhesions, and it is not uncommon for the fundus and body of the gallbladder to be well submerged, too. The writer has, therefore, always deemed it safer to begin the excision of the gallbladder at the fundus, since this is usually the least involved by pathological conditions, and work toward the more involved region in the danger zone. (Figs. 9 and 10.) The gallbladder when freed affords an excellent handle to raise the liver, to put the cystic duct on stretch, and to pull forward the deeper lying bile ducts. (Fig. 10.) Hartman has stated that the gallbladder is often the thread of Adridne which guides us through a labyrinth of adhesions to the position of the common duct. When the gallbladder is dissected free from the liver, the cystic duct and artery are drawn well up into the wound, and there they can be ligated together. Every stroke of the knife or scissors is thus made under direct vision, and in-

flammatory or other bands separated close to the gallbladder. When cutting across the cystic duct care must be taken

Fig. 15. Photo of the author's dissection showing how traction on the gallbladder during cholecystectomy will bring the cystic and common ducts into the same line. It is then possible to mistake the common for the cystic duct and crush it by clamp or ligature.

to avoid too much traction on the gallbladder or Hartman's pouch, so as not to pull up or angulate the common duct. (Fig. 8 T, U, V, X.) In doing cholecystectomy *from the cystic duct up*, the cystic duct having been cut first we are at once deprived of the above advantages; moreover if the accessory ducts as illustrated in Figure 7E, F, and G, are present the operator is in an uncomfortable situation. Therefore, the freeing of the gallbladder from the fundus down is preferred by the writer because variations can be noted first and the cystic duct can be freed more simply in this direction and it leads to the common duct. If the gallbladder is large, tense, or obstructs the approach to Calot's triangle, it can be partly emptied by aspiration. Long remnants of the cystic duct are thus not left behind with the possible sequelae of biliary dyskinesia.[14] Any vessel present can be clamped on or close to the gallbladder or cystic duct as encountered, and thus there is less danger of injury to the right hepatic artery or ducts. The great variations in the arrangement of the biliary ducts and hepatic and cystic arteries as illustrated occur in 70 per cent of cases.[13] Since it is unsafe to anticipate any regular or normal arrangement of these structures it is highly important in every case positively to identify the cystic duct and artery, regardless of their situation before they are cut or ligated. This is often difficult. If the duct is isolated and divided before the cystic artery, the cystic artery which is shorter may tear and retract with sharp hemorrhage deep in the wound. The relationship of the artery to the duct is almost like a bowstring to a bow, since it is shorter than the duct and lies on a plane closer to the liver. The cystic artery usually passes behind and not along the cystic duct to the gallbladder. The order must then be reversed and the cystic artery ligated first before cutting the cystic duct to prevent trouble. If one can localize and be certain of the position of each of these structures, there is certainly no objection to the method from the cystic duct up. Judd's method[15] of carefully catching the cystic duct and artery, exposing them together and separating them from the notch of the liver while sealed in their connective tissues and ligating them together may be tried. However, so many variations and adhesions are so often found in this inaccessible area that the inexperienced operator may mistake the common for the cystic and even the hepatic duct may be completely severed or a section of it removed. This accident can be avoided if the fundus and neck of the gallbladder are dissected carefully down to the cystic duct and the cystic duct followed to its junction with the common before it is ligated and divided (see Fig. 16). The cystic duct should not be removed flush with the common hepatic duct. (Fig. 8v.) It is safer to leave enough of the cystic duct to minimize the danger of later cicatricial contraction of the common duct. In all

cases of doubt it is much wiser to leave a small portion of the gallbladder than to run the risk of injuring the common or hepatic duct. Besides since there may be two cystic arteries, dissection from the fundus down would encounter and secure these vessels during dissection either on the wall of the gallbladder or behind the cystic duct. The contents are thus noted, stones can be felt and if a stone is impacted in the ampulla or cystic duct it can be pushed back into the gallbladder, giving easier access to and localization of the duct. The peritoneal coat is stripped off from the gallbladder leaving a margin of about three-fourths of an inch on either side and by blunt dissection the gallbladder is stripped from its avascular cleavage plane between the gallbladder and liver bed. (Fig. 10.) Traction on the fundus draws the gallbladder away from the liver bed until the cystic vessels and ducts are reached. (Fig. 10.) In this manner considerable portions of the cystic duct are not left behind and anomalies of the blood vessels and biliary ducts are more easily recognized. The cystic duct is delivered out of its depth, straightened out and ligated under better exposure and direct vision. Good exposure is often difficult if not impossible by any other method in this danger zone. The vessels when exposed in this manner usually lie to the inner and upper aspect of the neck of the gallbladder and cystic duct and can be easily clamped and ligated. Nothing should be clamped, cut or ligated unless positively identified. Constant visualization is essential to avoid injury to the ducts. Blind and careless application of a clamp to control hemorrhage from the cystic vessels is unpardonable. The cystic duct is then visualized and cut between clamps. If the dissection is begun at the neck of the gallbladder or at the junction of the cystic and common ducts, it may be almost impossible to define and expose these structures clearly because of the deformity, thickening and contracture produced in this zone by inflammation. (Fig. 9.) Ligation of the cystic artery at this point is likewise fraught with great danger since

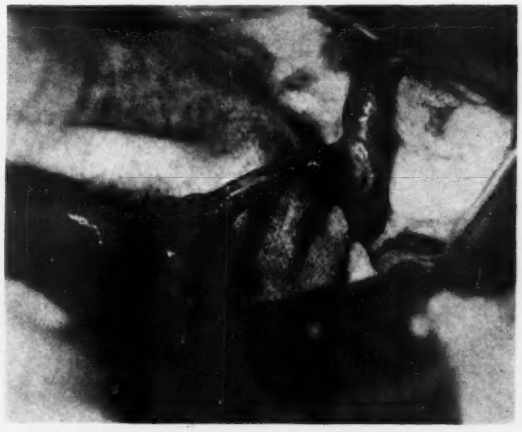


Fig. 16. Photo of the author's dissection of the junction of the cystic and common ducts. Note the usual length of the cystic duct. Note that the cystic duct is of smaller caliber than the common and enters same at right angles.

it can be confused with the right hepatic artery. After transfixion and double ligation of the cystic duct with chromic catgut, the bed of the gallbladder is sutured with fine plain catgut on an A-traumatic needle thus closing the raw surface of the gallbladder bed. Accessory bile ducts and variations of the normal bile ducts are so numerous that the writer always employs drainage following cholecystectomy. No harm is done by leaving a small Penrose drain in for several days and occasionally it saves a life. The terse saying of the late John B. Deaver is sufficiently emphatic in this respect. He stated that in a patient dying of bile peritonitis following cholecystectomy where no drainage had been employed, he would have inscribed on the tombstone, "Died following cholecystectomy without drainage."

Only a proper definition of the parts at operation combined with a detailed knowledge of the anatomy, particularly of the ductal and vascular structures, will prevent errors. Skill in cholecystectomy cannot be acquired in either ten easy lessons or five hard ones. The pitfalls of gallbladder surgery can be avoided

only through a detailed familiarity with the lay of the land coupled with experience and the ability to anticipate trouble.

SUMMARY

The problems of cholecystectomy are discussed. The important variations and anomalies of the bile ducts and blood vessels are demonstrated and their surgical significance in cholecystectomy emphasized. With the increased number of cholecystectomies there has been an increased incidence of bile duct injuries. Since prevention of injury is of paramount importance, a thorough familiarity with every possible variation in the biliary tract is mandatory.

Any surgeon performing cholecystectomy must be qualified to recognize and deal with safely any pathological conditions involving the extrahepatic ducts as well. The extrahepatic ducts and their related blood vessels are, therefore, demonstrated by diagrams and photographs of the author's dissections. The right hepatic artery instead of the cystic not infrequently forms the base of Calot's triangle; it can, therefore, be mistaken for the cystic artery and ligated accidentally with death of the patient.

The author prefers cholecystectomy *from the fundus down* and believes this method safer than cholecystectomy *from the cystic duct up*. The reasons for this are given. Cholecystectomy should always be accompanied by drainage.

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Functional stenosis of the lower end of the esophagus is usually successfully treated by *dilatation methods*. An air-inflated rubber bag is commonly used. Mechanical digital dilatation through an incision in the stomach may be indicated in rare cases.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

SHAFT FRACTURE IMMOBILIZATION WITHOUT PLASTER

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THE principal inadequacies of the usual method of treating fractures of the shaft are: (1) Necessity for plaster immobilization with resultant ill effects upon adjacent joints. Such effects are occasionally permanent or entail a long period of inactive convalescence. (2) Uncertainty of accurate reduction of the fracture. The attention of the general surgeon is directed to a means of obviating these defects by use of a modified bone plate assembly developed by the author.

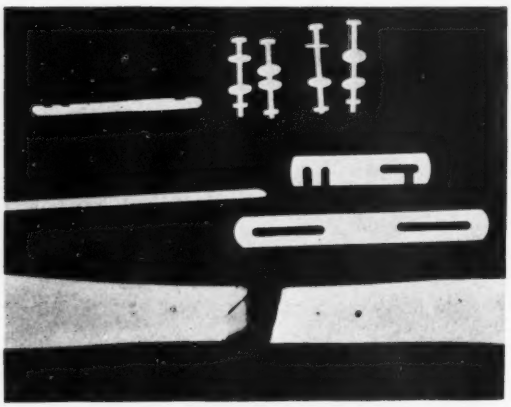

FIG. 1. Apparatus used for fixation of shaft fractures, four bolts with washers and a pair of slotted plates; front and side views.

Each assembly consists of two plates and four bolts made of Vitallium. One plate, called the front plate, is made with two slots in place of the series of holes used in the Sherman or Lane plate. The second plate, known as the back plate, is shorter and has a T-slot at one end and two comb-like openings at the other end. (Fig. 1.)

OPERATIVE PROCEDURES

The detail of using the assembly consists of first making an incision at the site of the fracture, and then aligning the fracture in anatomical reduction. While this is held in position by an assistant, the front plate is placed across the side of the fracture nearest the operator, and with a gimlet, four bone marks are made, two through each slot. The two outer marks should be as far away from the fracture site as the plate will permit, and the two inner bolts as close together as the plate will permit. Extreme accuracy is not vital as long as the four marks are in the same line. The plate is then lifted away from the bone. Each fractured fragment is lifted out of the tissue, and by means of the drill, either electric or hand, four holes are made, two in each fragment, running through both cortices. The proper length bolts are then inserted from the *opposite* side and the fragments placed back into anatomical position within the soft tissue. This leaves the fracture lying in anatomically correct position with four bolts projecting toward the operator. The slotted plate is then simply placed over the four bolts. Washers are slipped on, and the nuts are loosely fastened to the four bolts. The assistant now impacts the fracture. The slotted arrangement of the plate permits the forceable impaction of the fracture ends and maintains the anatomical alignment. The two outer bolts are then securely tightened, but the two inner bolts are left loose until the back plate is slipped into position under the bolt heads. (Figs. 2 and 3.)

When the back plate is inserted over the two inner bolts, these two are tightened with the wrench, and the immobilization is complete. The construction of the back plate, as can be seen from the drawing, permits compensation for inaccuracies in the position of the bolt holes. A simple sterile dressing is used over the wound.

Special attention is called to the necessity, in the operating technic, of entering

the four bolts from the side of the bone opposite the operator and of using the front plate on the side near the operator.

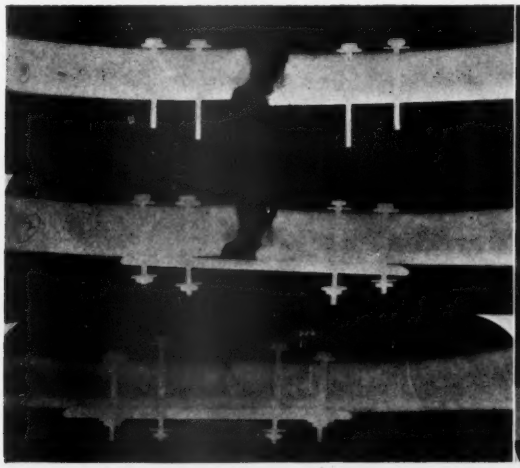

Fig. 2. 1, bolts in position through drilled holes; 2, slotted plate in position before fracture is impacted; 3, impacted fracture with two outer bolts tightened.

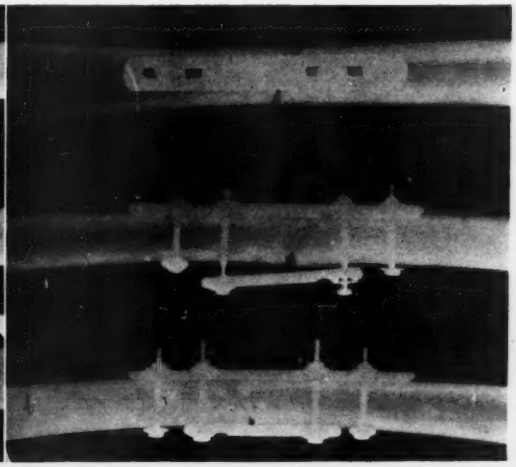

Fig. 3. 4, Other view of slotted plate in position with outer bolts tightened; 5, smaller plate slipped into position over two inner bolts; 6, thorough immobilization with all bolts fastened securely, both plates in position and fracture impacted.

It will be obvious also that a plate assembly of different size is required for each type of bone to which this method is applied. Bolts of adequate length must also be available. The excess length may be removed by means of cutting pliers with a high leverage factor.

CASE REPORTS

In a patient with a fracture of the femur to which this procedure was recently applied, it was noticed that within twenty-four hours following operation the patient actively moved the limb in bed. He was able to flex the hip and knee about 20 degrees and was able to abduct and adduct the extremity with practically no distress. In a second case, involving non-union of the middle of the tibia, the patient was made ambulatory with the aid of crutches on the fifth day postoperatively.

SUMMARY

The chief advantages of this method are the ability to impact the fracture before the bolts are tightened, and the fact that the fixation* is so rigid that plaster immobilization is not necessary. Experiments on the cadaver and in the operating room prove the immobilization so rigid that manipulation of the extremities fails to disrupt the fracture reduction and impaction. Because of this, plaster of Paris need not be used. The joints above and below the fracture site are left free for active motion.

* These Vitallium plates are manufactured by the Austenal Company of New York City.

REFRIGERATION ANESTHESIA

WITH SPECIAL REFERENCE TO TREATMENT OF A SEVERELY DAMAGED EXTREMITY COMPLICATED BY VISCERAL INJURY

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THE ability of lowered temperature to produce anesthesia has been known for many years and its application to surgery has been demonstrated by the work of Allen.[1] The advantages of this type of anesthesia are particularly apparent in the following types of cases:

First: For chronic circulatory failures of the extremities, such as, gangrene due to arteriosclerosis, diabetes and Berger's disease, etc.[2,3,4]

Second: In cases of acute circulatory disturbances, such as injury to major arteries or embolus, refrigeration anesthesia has given the extremity time to develop collateral circulation thus permitting a more distal amputation than might appear necessary on first examination.[5,6]

Third: In severe infections the local process can be placed in "suspended animation" often giving the surgeon needed time to build up the patient for the operative procedure. The therapeutic measures in the hands of the surgeons, such as repeated transfusions, sulfa drugs, penicillin, etc., frequently require a longer time than one would choose to wait when the infected extremity is kept at body temperature.[7]

Fourth: Another undoubted value of this type of anesthesia is the control of traumatic shock. In these days of world-wide conflict and speeded up production, the treatment of shock has come to assume a major rôle. The value of plasma, etc., is certainly not to be reduced in any degree; however, the addition of refrigeration anesthesia, whenever feasible, seems to be a definite adjunct in the armamentarium of a surgeon.[8]

The author wishes to present briefly eight amputations performed under refrigeration anesthesia. The ninth case is presented in detail as it appears to demonstrate the particular value of refrigeration anesthesia in certain severe traumatic cases.

Case number one is of particular interest as the child fell on a bottle causing severe laceration of the popliteal space including the popliteal artery and vein. There was gangrene and infection of the foot. Prior to application of ice it appeared as though femoral amputation would be necessary. However, following refrigeration a definite demarcation developed above the ankle, thus permitting an amputation approximately five inches below the knee.

In Case number two the patient was discharged from the hospital with the stump healed and he expired at home.

In Case number four the patient had severe heart disease with gangrene of toes due to embolus. This patient was moribund and had another type of anesthesia been necessary, no amputation would have been attempted. He expired two days after the operation.

In Case number eight the patient had a 4 plus Wassermann of spinal fluid and blood and aortitis. The severe Charcot's joint had become infected and it was believed that he would not survive a general anesthesia. The patient withstood the refrigeration anesthesia and amputation very well; however, the stump became infected. It would appear there are two factors which may have caused this infection: (1) the fact that there seems to be some delay in healing, and (2) the amputation was done too close to the edematous tissue of the Charcot joint.

Cases three, five, six and seven are self-explanatory from the table.

TABLE I

Name	Age	Sex	Race	Diagnosis	Site of Amputation	Comments
1. D. P.	9	F	Wh.	Traumatic severance of popliteal artery with gangrene and infection of foot	Five inches below knee	Healed
2. A. P. G.	76	M	Wh.	Arteriosclerotic heart disease with gangrene of foot	Mid thigh	Healed; expired after leaving hospital
3. J. B. W.	70	M	Wh.	Embolus with gangrene	Mid thigh	Healed
4. A. S.	54	M	Wh.	Embolus and gangrene with infection; patient moribund	Mid thigh	Expired two days
5. R. B. J.	80	F	Col.	Arteriosclerotic gangrene	Mid thigh	Healed
6. M. H.	67	F	Wh.	Diabetic gangrene	Mid thigh	Healed
7. N. C.	74	F	Wh.	Arteriosclerotic gangrene	Mid tibia	Healed with one eschar 2 cm. in diameter
8. O. S.	57	M	Wh.	Infected Charcot's knee with aortitis	Mid thigh	Stump infected
9. R. H.	31	M	Wh.	Dislocation of knee with macerated right tibia; fractured pelvis; ruptured bladder and urethra	Mid thigh	Healed

Mortality 2—equals 22 per cent including one patient who died at home after discharge from hospital.
Mortality in hospital—11 per cent.
Cases one to four from service of Hugh A. Bailey, M.D.
Cases five and six from service of J. E. Cannaday, M.D.

CASE 9, PRESENTED IN DETAIL

A white male, age thirty-one, a coal miner, was run over at the right upper tibia by a loaded car. It dragged him about thirty feet and crushed his pelvis. This happened at approximately 2:30 P.M. and the patient reached the hospital at 6:00 P.M. On admission he was in severe shock; blood pressure could not be obtained and his pulse was thready and hardly palpable. The upper third of the right tibia was completely macerated with extensive damage to the muscles and skin up to the knee and the right knee was dislocated. Pressure on the pelvis produced grating. Patient was immediately placed in shock position and 500 cc. of plasma started. At 6:30 P.M. the blood pressure rose to 76/40. Adrenal cortex 5 cc. was given intravenously. At this time an attempt was made to catheterize the patient and only pure blood was obtained. The second 500 cc. of plasma was begun. At 10 o'clock P.M., the blood pressure had risen to 100/60. The patient was taken to the *x*-ray department where an intravenous pyelogram was made. This showed complete rupture of membranous urethra and entraperitoneal rupture of the bladder. Other *x*-rays taken at this time showed comminuted fractures of the sacrum, also both pubis and ischium with slight overriding of the fragments of the ischium, right knee dislocated and right tibia and fibula showed a splintered fracture of the upper one-half of the shaft. The patient was treated further for shock by starting the third 500 cc. of plasma and by approximately 12 o'clock midnight, the blood pressure had risen to 120/60.

At this time the patient was taken to the operating room and the rupture in the bladder and urethra were repaired through a suprapubic incision. Following this procedure, the patient's blood pressure was 95/40. It was rather obvious that there would be no hope of saving the right leg below the knee. At the time of repair of the bladder and urethra, serious consideration was given to the possibility of performing mid-thigh amputation; however, it was decided to encase the macerated leg in ice with a tourniquet above the knee and wait for further development. Immediately on placing the patient in bed 500 cc. of whole blood was started. Blood pressure taken every thirty minutes showed a gradual rise.

At approximately thirty-six hours later, the blood pressure had risen to 140/90 and the patient's general condition was greatly improved. The right leg was still encased in ice. The rubber sheet technic as demonstrated by Crossman, Allen et al.[9] was followed. At this time a decision was made to perform mid-thigh amputation. Therefore, a second high thigh tourniquet was applied and the ice was extended up to the groin. Three hours later, that is, approximately thirty-nine hours since the application of ice, the patient was moved to the operating room in bed. It was believed that it would be inadvisable to move the patient out of the bed due to the fact that he had severe fractures of the pelvis. Mid-thigh amputation was done with the patient in bed. The usual technic of Kirk was employed. The patient experienced pain when the sciatic nerve was cut, otherwise he appeared to have no particular discomfort. His blood pressure, pulse and respiration did not show any change during or after the operation. The muscles and skin were closed over the stump with cotton sutures, the complete operation requiring approximately one hour. Ice bags were applied to the stump. These were removed one at a time within the next five days. On returning to his room, an overhead frame was applied with pelvic sling for treatment of his fractured pelvis.

Postoperatively, the patient was given repeated small transfusions. He ran a low-grade fever and for a time complained of pain in the abdomen. This was probably due to the cystotomy and fractured pelvis. The stump of the right thigh healed per primum and three weeks later the patient became afebrile. Five weeks later his suprapubic cystotomy was healed. The pelvic sling was left on this patient for seven weeks at which time *x*-ray examination showed healing in satisfactory position and he was fitted with a lumbosacral corset and discharged from the hospital.

SUMMARY

In the care of the usual types of severe injuries to the extremities one is able to proceed with definitive therapy following the treatment of shock which is frequently present. There are, however, some cases of injuries to the extremity complicated by visceral damage. Before the advent of refrigeration anesthesia, the surgeon was left in a quandary trying to decide what should be done first.

It is generally agreed that visceral damage must receive immediate treatment and when an attempt is made to carry out major amputations at the same time, the outcome is usually fatal. In the opinion of the author, the use of refrigeration anesthesia seems to make it possible to delay the treatment of the extremity without harmful effect to the patient.

When the decision is reached regarding the necessity of sacrificing the extremity a tourniquet must be applied and amputation must be done above this level, thus several inches more of the extremity must be lost. The tourniquet appears necessary due to the rather considerable oozing that one sees in severely macerated extremities with comminuted fractures even after the major vessels have been ligated. It is rather difficult to reach a definite decision to amputate and then continue to wait. However, in the case presented, packing the injured leg in ice and waiting thirty-nine hours appears to have been of definite aid to the patient. Dissection of the amputated specimens have shown some soft clot formation. One naturally wonders if this type of anesthesia might not be used also for short reconstructive surgeries of the extremities when other anesthesias are contraindicated.

The author wishes to express his appreciation to Dr. J. E. Cannaday and Dr. Hugh A. Bailey for permission to include their cases in this report. The urological treatments were rendered by Dr. G. G. Irwin.

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METHOD OF REMOVING T-TUBES FROM THE COMMON BILE DUCT

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THE removal of T-tubes from the common bile duct is frequently associated with temerity on the part of the person removing the tube. Most surgeons pull the tube out briskly when they have decided that it has served its usefulness. This practice was followed by us until a disastrous experience altered our method.

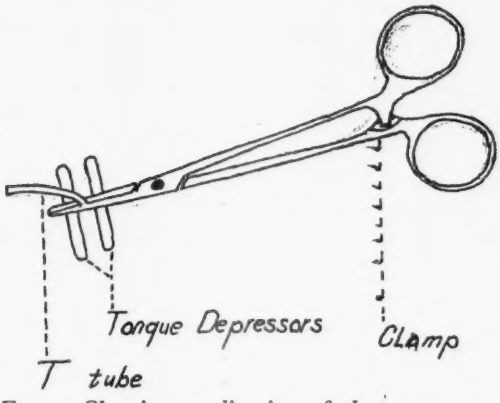

FIG. 1. Showing application of clamp over two tongue depressors on the anterior abdominal wall.

At present we follow a routine which may be interpreted by others as excessive labor for a simple procedure. However, since the adoption of this routine we have encountered no difficulties. For the past two years we have removed T-tubes from the common duct in the following manner:

During morning rounds two tongue depressors are placed on either side of the tube to be removed. With slight pressure on these blades the abdominal wall is depressed. The T-tube is then clamped with a Kelly clamp close to the tongue blades. (Fig. 1 and 2.) When evening rounds occur, the visible portion of the T-tube is usually found to have increased an inch or more. The abdominal wall is no longer depressed and the T-tube is out of the common duct and is in the peritoneal cavity. The tube is then painlessly pulled through the skin orifice.

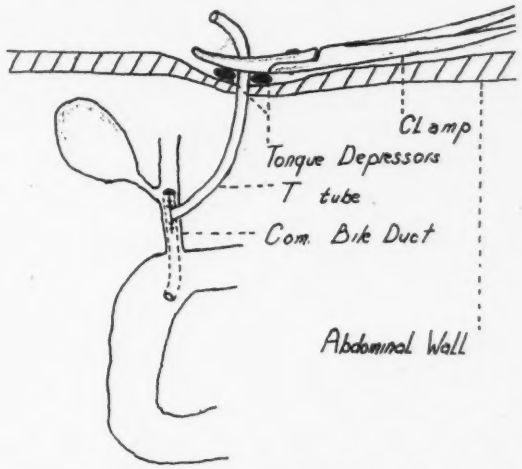

FIG. 2. Cross section view showing T-tube under tension due to spring-like action of the abdominal wall.

The dynamics by which this has occurred resolves about: (1) The resiliency of the abdominal wall which acts like a spring as it pulls the T-tube out of the duct gradually; (2) where the spring-like mechanism appears to be inadequate, as in thin-walled individuals, the abdominal respiratory excursions are sufficient for extirpating the tube from the duct. On several occasions we have encouraged an apprehensive patient to breathe with a sand bag on the chest. This accelerates diaphragmatic breathing with a resultant increase in intra-abdominal pressure. This pressure causes an increase in the antero-posterior diameter of the peritoneal cavity.

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An increase in diameter such as this pushing against a fixed point (the clamp) pulls the tube out of its surroundings. (3) More recently we have simply requested the patient to sit up in bed after the application of the clamp and the tube is removed immediately. The removal is accomplished through the contraction of the rectus muscle which increases the width of the abdominal wall one, two or more inches depending upon the muscular development of the individual.

This procedure has been painless to the patient and very convenient to the surgeon, especially in the management of a timid patient fearful of the removal of the tube. It is hoped that others will employ this method and find it as convenient for themselves as it is for us; even as it is painless to the patient.

METASTATIC abscesses and metastatic tumors may spread to areas that do not seem to be in line of direct spread from their primary focus. There is even a regularity of distribution of these paradoxic metastases, according to Batson.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

Case Reports

CECOCOLIC INTUSSUSCEPTION IN THE ADULT

CASE REPORT

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MEDICAL CORPS, ARMY OF THE UNITED STATES

INTUSSUSCEPTION in the adult is an uncommon lesion, but when it does occur, unlike the situation in children, there is usually a definite inciting factor, such as a polyp or polypoid tumor. In the case reported herein, the wide mesentery of the terminal ileum, cecum, and ascending colon was the predisposing factor which made the intussusception possible. At the time of the first laparotomy an inciting factor was expected and careful search was made for it. A decision could not be reached at this time regarding the nature of the localized tumefaction of the lateral wall of the cecum, but re-examination one month later confirmed the impression that the lesion was secondary rather than primary. Re-examination also established the efficacy of a series of interrupted seromuscular sutures in the fixation of the bowel to the posterior abdominal wall. Fixation at this time had occurred over a wide area and was very secure.

In retrospect it is quite possible that intussusception of varying degree had occurred repeatedly, only to reduce itself spontaneously. In confirmation of this one may point out that the symptoms had begun thirteen days prior to operation, but had varied rather than increased in severity and that the mass had been observed to disappear and reappear several times in the last few days before operation. Furthermore, at the time of operation the distal ten inches of ileum, though not at the time involved in the intussusception, were edematous and indurated as if recently so involved.

CASE REPORTS

The patient was a twenty-six year old white soldier who, prior to induction twenty-eight months before onset of present illness, had been a farmer in the middle west. His family history was irrelevant. He had had the usual childhood illnesses. In 1925, at seven years of age he had a tonsillectomy, and in 1930, an appendectomy. In 1937, he had gonorrhea which was promptly treated and was thereafter asymptomatic until October, 1941, when he had a urethral discharge for one month.

This patient entered a General Hospital on October 20, 1943, complaining of pain in the right flank of three months' duration, and frequency and nocturia of eighteen months' duration. The pain occurred infrequently, usually lasted fifteen to twenty minutes, was specifically located in the right costovertebral angle, and did not radiate. It usually occurred after exertion, especially after lifting heavy weights.

Complete investigation in October, 1943, revealed a somewhat enlarged soft prostate which on massage yielded an exudate containing many pus cells, some of them in clumps. Excretory and retrograde pyelograms revealed an extrarenal pelvis on both sides, some pyelectasia, which was more marked on the left, and blunting of the calices, which was interpreted as a mild bilateral hydronephrosis. The right kidney was moderately nephroptotic.

The patient was transferred to the Zone of Interior and admitted to the hospital on the Genito-Urinary Section on November 29, 1943. During transit his symptoms had subsided. Retrograde pyleograms on December 3, 1943, were interpreted as normal;

each pelvis revealed only developmental anomalies. The prostate had returned to normal. The patient was about to be discharged to duty when he began to complain of a new group of symptoms.

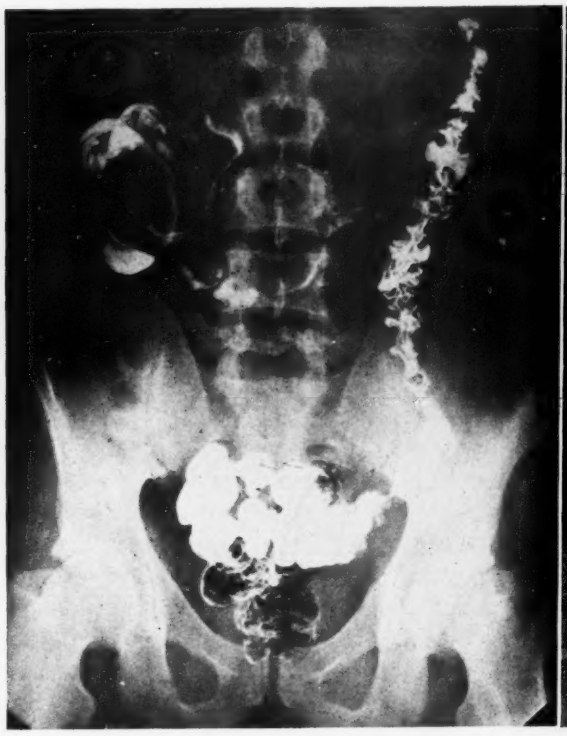

Fig. 1. *X*-ray appearance of colon eighteen hours after ingestion of barium demonstrating intussusceptum.

Fig. 2. *X*-ray appearance of intussusceptum as outlined by retrograde barium enema filling.

On December 5, 1943, the patient began to have moderately severe intermittent cramp-like pain at various points within a twelve inch circle about the umbilicus. This pain recurred repeatedly throughout the day and night and interfered with sleep. It was aggravated by imbibing fluids, especially if cold, and by ingesting foods, so that the patient gradually lost his appetite and began to lose weight. His bowels continued to function quite regularly, without noticeable effect on the pain. Five days after onset of this pain, the patient began to vomit once daily after supper. This vomiting was not of the cumulative type.

On December 14, 1943, the patient was examined by a general surgical consultant and a mass the size of a small grapefruit was found in the right upper quadrant of the abdomen, attended by visible and grossly audible peristalsis. The patient was transferred to the General Surgical Section.

The patient was a thin, chronically malnourished young male with sallow complexion. His skin and mucous membranes were somewhat dry. Other positive findings were limited to the abdomen. The latter was scaphoid. Neither liver nor spleen were palpable. There was a well healed McBurney scar. In the right upper quadrant, more specifically the right upper para-umbilical quadrant, there was a well defined but rather soft, non-tender mass the size of a small grapefruit. There were visible and grossly audible peristaltic waves in this region which seemed to lift the mass into greater prominence during various periods of observation. Rectal examination was negative.

The patient's course thus far had been afebrile. His laboratory data revealed no striking abnormality. Repeated urinalyses had been normal. Red blood count was 4.09 million, white blood count 7,100; hemoglobin 12.5 Gm. Sahli. The differential revealed 56 per cent neutrophils, and 44 per cent lymphocytes. Non-protein nitrogen was 31 mg. per cent, chlorides 406 mg. per cent, icteric index 8.1, plasma protein 6.9 Gm. per cent.

Proceeding on the assumption that the patient had a partial intestinal obstruction,

the significance of the mass was not at once realized. A scout film revealed no diagnostic gas shadows. It was therefore decided to fluoroscope the patient and study the progress of a small amount of thin barium suspension administered by mouth. Barium passed normally through the stomach, duodenum, and small bowel, revealing no abnormality except for an inverted U-loop of the first portion of the duodenum. A film taken eighteen hours after ingestion of barium revealed the barium stretching out in large thin circles in the region of the transverse colon just distal to the hepatic flexure. Distal to this the colon, which contained some barium, became abruptly contracted. (Fig. 1.)

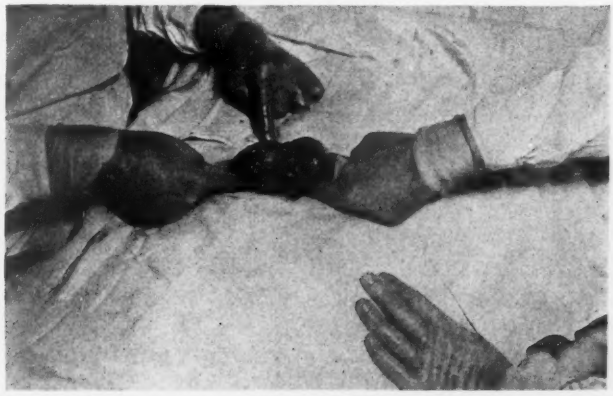

Fig. 3. The tumor mass lies to the right of the upper index finger, the terminal ilium to the left, demonstrating that the cecum and ascending colon have intussuscepted.

It was now quite obvious that the patient was suffering from obstruction of the large intestine, almost certainly caused by intussusception. It was also clear that the obstruction was only partial and that strangulation had not yet occurred. Because the patient was not acutely ill, a barium enema was done while preparations were being made for operation. Meanwhile he was also given parenteral fluids, including plasma. The barium enema confirmed the diagnosis of intussusception. (Fig. 2.)

On December 18, 1943, operation was done under intratracheal gas oxygen ether. There was a little clear, straw colored fluid in the peritoneal cavity. Exploration revealed that the cecum and ascending colon had intussuscepted into the proximal third of the transverse colon. (Fig. 3.) Reduction of the intussusception was fairly easy. There was no evidence of acute strangulation, but the intussusceptum and the distal ten inches of ileum, which was not found intussuscepted at the time of operation, were edematous and chronically thickened, as if they had been recently involved in an even more extensive process. After reduction the ascending colon, cecum, and distal twelve inches of ileum were found to be free on a fairly wide mesentery. On the lateral wall of the cecum there was a knob-like tumor mass 3 cm. in diameter and 0.75 cm. in thickness which had apparently formed the head of the intussusception. Its internal surface felt smooth and its borders gradually blended with the cecal wall. (Fig. 4.) It could not be determined whether this tumor mass was merely due to chronic induration from repeated intussusception, or to an early neoplasm, so a side-to-side ileotransverse colostomy was done in anticipation of possible resection later. A large soft lymph node was removed from the transverse mesocolon. Before closure the ascending colon and cecum were

Fig. 4. After reduction of intussusception demonstrating the mobility of ascending colon and cecum. The indurated lateral wall of cecum is held upward on the left.

fixed to the peritoneum of the lateral gutter with a series of sutures in order to prevent a recurrence of the intussusception.

The patient made an uneventful recovery. He was ambulatory in three weeks. The pathological report classified the node removed from the transverse mesocolon inflammatory in nature. A barium enema was done on January 10, 1944, but the cecum could not be well enough demonstrated to rule out an early sessile tumor. As originally planned at the time of the first operation an exploratory laparotomy was done on January 14, 1944. The cecum was examined by palpation and direct vision and the localized tumefaction of its lateral wall, as well as the edema and induration of the terminal ileum, cecum and ascending colon had completely disappeared. Moreover, the cecum and ascending colon were firmly adherent to the lateral gutter.

The patient again made an uneventful recovery. Visceral functions remained normal, the patient gained weight, suffered no pain, and two months later, was ready for return to full duty.

SUMMARY

1. The case history of a cecocolic intussusception in a young adult has been presented.

2. The lesion caused neither complete intestinal obstruction nor strangulation.

3. A predisposing factor, the presence of a wide mesentery, was found at operation, but there was no inciting factor.

4. *X*-ray films demonstrating the lesion after both oral and rectal administration of barium have been reproduced.

5. The measures employed to prevent recurrence of the lesion have been outlined.

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SIMULTANEOUS PRIMARY CARCINOMAS OF THE STOMACH AND SIGMOID

CASE REPORT

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IN 1937, Pemberton and Waugh[4] reported a unique case in which two primary carcinomas appeared simultaneously, one in the sigmoid flexure and the other in the stomach of the same individual. Both of the lesions were amenable to surgical treatment. It was pointed out that the finding of multiple primary carcinomas in the same individual was becoming of increasingly common occurrence. The incidence of cases in which simultaneous, multiple primary malignant growths have appeared, as revealed in published reports, varies from 0.6 per cent to 7.8 per cent among all cases of malignancy. Review of the literature, in 1937, revealed but thirty-four reports of instances in which independent carcinomas involved the colon and stomach of the same patient; the case which was reported then brought the total to thirty-five. The sigmoid flexure was said to be involved in only four of the cases reviewed.

The following case, encountered recently at the Mayo Clinic, is similar to the case reported in 1937 in that it presented the rare combination of two clinically demonstrable, separate and distinct carcinomas, both amenable to surgical removal, occurring simultaneously in the sigmoid portion of the colon and in the stomach of the same individual.

CASE REPORT

A man, sixty-eight years of age, came to the Mayo Clinic November 18, 1943, complaining of gaseous indigestion and a sensation of fullness after meals. About three months before his admission, he had begun to notice bloating, fullness and gaseous eructations occurring immediately after eating, as well as anorexia and, at times, slight nausea. Approximately one month later, the patient had begun to experience intermittent epigastric pain which had occurred about two hours after eating and which had not been accompanied by nausea nor emesis. The pain was not relieved by taking of food, but occasionally was relieved by taking alkali. The man had lost six pounds (about 3 kg.) during the two months before his admission.

Five years prior to onset of the present symptoms, the patient had noted epigastric pain which occurred when his stomach was empty, accompanied by slight nausea, but relieved by taking of food. This distress had been noted intermittently for three or four months; then it had disappeared and had not recurred until onset of the present symptoms. Two years before his present illness, the patient had noted black stools for three or four days and, for the past six or seven years, occasionally he had noted the passage of small amounts of bright blood from the rectum.

In 1941, active pulmonary tuberculosis had been diagnosed elsewhere, and a chronic, hacking cough had persisted, with occasional intermittent thoracic pain. The patient's past history was otherwise negative. He had not undergone any surgical operation.

Examination at the clinic revealed a pale, thin, elderly man whose weight was about twenty-two pounds (about ten kg.) less than the so-called normal for his age and height. Râles and increased breath sounds were heard in the upper left portion of the thorax. The abdomen was negative to examination except that bilateral inguinal hernias were found. Digital examination of the rectum revealed a small, firm mass, which was not tender, high on the posterior wall. Urinalysis and examination of the blood did not reveal any abnormality beyond slight secondary anemia. Roent-

genographic examination of the thorax gave evidence of active pulmonary tuberculosis; it suggested, furthermore, the presence of cavitation in the upper lobe of the left lung and fibrous tuberculosis in the upper lobe of the right lung. Examination of the sputum for Mycobacterium tuberculosis gave a negative result at this time but several positive specimens were obtained later.

Total acidity of the gastric content was 40 and free acidity 30, according to the method of Töpfer. Mycobacterium tuberculosis was found to be present in the gastric content. Roentgenoscopic examination after a barium meal disclosed the presence of an ulcerating carcinoma in the distal half of the stomach; the lesion appeared to be operable locally.

Proctoscopic examination of the rectum and rectosigmoid for a distance of 24 cm. demonstrated a freely movable carcinoma, measuring 4 by 2.5 cm. at its base, involving the left and posterior rectal walls at a distance of 15 cm. from the anus. A specimen taken for biopsy at the time of the proctoscopic examination was found to be characteristic of adenocarcinoma of malignancy graded 2 (Broders' method).

The clinical diagnoses were: (1) carcinoma of the stomach, (2) carcinoma of the lower part of the sigmoid and (3) pulmonary tuberculosis. Both carcinomas were believed to be operable.

Exploration of the gastric lesion was undertaken by one of us (J. deJ. P.) on November 22, 1943. Anesthesia was by intratracheal nitrous oxide, oxygen and ether. Preliminary examination through an upper midline incision revealed a carcinoma of the distal half of the stomach which had perforated onto the serosa and through the transverse mesocolon. The middle colic artery was not involved. Examination of the lower part of the sigmoid revealed a freely movable lesion which, it was believed, could be removed later by an exteriorization operation after adequate mobilization of the rectum. Metastatic lesions were not palpable in the liver.

The involved segment of mesocolon was removed without interference with the blood supply of the transverse colon, and resection of the distal half of the stomach was accomplished by turning in the end of the duodenum and establishing a posterior Pólya type of anastomosis. The lesion in the stomach was found to be an adenocarcinomatous ulcer measuring 3 by 2 by 2 cm., of malignancy graded 3; it was on the lesser curvature of the stomach, 3 cm. above the pylorus. The lesion infiltrated the surrounding tissues to cover an area 6 cm. in diameter. Several involved lymph nodes were found.

On January 31, 1944, after an uneventful convalescence following the first operation, the lower part of the abdomen was entered through a low left rectus incision. Spinal anesthesia was employed. A small tumor was found in the lower part of the sigmoid, about 10 cm. above the peritoneal fold. There was no perforation of the wall of the bowel nor any adhesion of the sigmoid to surrounding structures. The left portion of the pelvic peritoneum was freed up and after the rectum had been mobilized, the portion of bowel about and including the tumor was brought out as the first stage of a Mikulicz exteriorization operation. On February 9, 1944, the exteriorized loop was removed, by means of a cautery, flush with the aponeurosis of the external oblique muscle. A clamp was applied to the spur of the colonic stoma. Examination of the 12 cm. of sigmoid colon removed, disclosed a sessile type of adenocarcinoma, of malignancy graded 2, measuring 5 by 3 by 1.5 cm., with nodal involvement. Convalescence was satisfactory and, on March 6, 1944, the opening in the colon at the site of the Mikulicz operation was closed around a small clamp applied to the remnant of the colonic spur. When the patient was dismissed on March 22, 1944, the colonic stoma had closed except for a small area which, it was believed, would close spontaneously.

COMMENT

Interesting is the fact that in this case both of the lesions were recognizable clinically. The majority of multiple primary carcinomas reported in the literature have been found at necropsy. In only two of eighteen instances of multiple, primary malignant growths reported by Hanlon[2] were the multiple growths recognized clinically.

It is now generally accepted that Billroth's[1] original criteria for the diagnosis of multiple primary maglignancy are too strict, and the rules substituted by Warren and Gates[7] are considered adequate: (1) Each tumor must present a definite picture

of maglignancy. (2) Each tumor must be distinct. (3) The probability of one tumor being a metastatic growth from the other must be excluded.

Since 1937, two cases in which primary multiple carcinomas occurred simultaneously in the stomach and colon have been reported. Maingot,[3] in 1938, reported exteriorizing a small carcinoma at the commencement of the sigmoid colon and subsequent subtotal gastrectomy for a simultaneous malignant growth in the stomach. Tullis,[6] in 1942, in a review of 1,044 necropsies, mentioned one case in which malignant growths occurred simultaneously in stomach and ascending colon. Stalker, Phillips, and Pemberton,[5] in 1939, mentioned a patient who in 1936 underwent resection of a portion of the descending colon which contained an adenocarcinoma of malignancy graded 2 and, in 1937, appeared with an adenocarcinoma of the stomach, graded 4. The malignant tumors in this case, however, do not appear to have occurred simultaneously.

These three, with our case, make a total of thirty-eight reported instances of independent carcinomas which involved the colon and stomach and, so far as we know, the case reported in 1937, the case reported by Maingot,[3] and the case herein cited are the only recorded instances of successful surgical removal of simultaneous, independent carcinomas of the stomach and sigmoid colon.

We are pleased to add that a communication in February, 1944, from the patient whose case was reported in 1937, informed us that he was alive and in good health. Eight and a half years have elapsed since his operation.

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OSTEOID OSTEOMA*

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OSTEOID osteoma, which has been recognized for a long time under the title of non-suppurative or sclerosing osteomyelitis, is a lesion which can usually be readily diagnosed. But at times its identification may present difficulties, particularly if its location is in a position which does not permit accurate roentgenographic visualization, or if there is an associated tissue reaction which simulates another disease.

Clinically osteoid osteoma has a triad of significant features which should always lead at least to a suspicion of its existence: First is localized pain. The onset of pain, usually in an extremity, is gradual. The pain at first mild and intermittent increases in severity and, after a variable period of some months, becomes persistent and continuous. The greatest intensity of the pain is always in the *same location* and is characteristically limited to a *comparatively small area* which may be surrounded by a large surface with less severe pain. Second, if the area of the lesion is accessible to physical examination, and it usually is, there is *tenderness* to pressure in the region of the greatest intensity of the pain. And, even when there is a wide spread perifocal reaction and general sensitivity, the most marked tenderness will still be limited to a small zone or spot. Third, the roentgenogram exhibits a small round or oval rarefaction of bone at the approximate site of the pain and tenderness. The rarefied area is surrounded by a zone of sclerosis which may appear as a narrow ring or may extend for several inches beyond the central focus. The triad of localized pain and tenderness and the pathognomonic roentgen changes are not accompanied by any systemic disturbance. The customary laboratory tests are negative. The functional disturbance depends upon the location, duration of the lesion and the patient's sensitivity to pain. Even in instances of extensive perifocal sclerosis there is little inhibition of motor function unless the lesion is adjacent to a weight-bearing joint.

As an example of the typical osteoid osteoma I would like to cite the case history of a patient recently treated at the hospital:

CASE REPORTS

R. L., a boy of seventeen years, consulted me in August of last year for pain in the upper part of the left leg and a limp. About four months previously, without any known trauma or pre-existing illness, he began to experience pain in the leg. This occurred infrequently and he paid no attention to it. Gradually the pain increased and he occasionally limped. Neither the pain nor the limp interfered with his physical activity, and he continued to work as a farmer's helper and indulged in vigorous athletic exercises. In recent weeks the limp became more noticeable, the pain more intense and he observed that his leg hurt whenever he chanced to press it against a hard object such as a table leg. The examination revealed a mild swelling on the outer surface of the upper part of the leg and tenderness to pressure over the upper extremity of the shaft of the fibula in the area of the pain. An *x*-ray film (Fig. 1) showed a typical lesion in the upper metaphysis of the fibula. There was an irregularly oval rarefaction within the fibula surrounded by an extensive bone sclerosis. The diagnosis was confirmed at operation and by the subsequent pathological examination. The lesion was excised completely by resecting the involved segment of the fibula and the patient has been entirely relieved.

* Read before the Clinical Society of the Hospital for Joint Diseases, March 14, 1944.

In the exceptional or complicated case the diagnosis may be very difficult. At times the final opinion may have to be postponed until the pathologist examines the diseased tissue.

Fig. 1. Typical osteoid osteoma of the fibula. There is an oval area of rarefaction in the upper metaphysis surrounded by an extensive osteosclerosis.

As an example of this type of problem I wish to recount the experiences in a girl, ten years of age, who had been complaining of backache for about a year. The symptoms started in October, 1942, shortly after she had begun having dancing lessons. The specific complaint was pain in the dorsolumbar region of the spine. Since she had previously been well it was assumed that the dancing exercises had initiated a strain of the back. Rest did not relieve her pain. A subsequent roentgenogram allegedly showed a mild lumbar scoliosis for which corrective exercises were prescribed. The backache continued. More *x*-ray films were made and a diagnosis of osteochondritis of the spine was suggested. She was then hospitalized, traction was applied for several weeks and finally a plaster of Paris jacket was put on for support of the back. All during this time the pain continued and in fact became worse. Lateral roentgenograms showed a slight kyphos at the level of the first and second lumbar vertebrae with diminution in the size of the intervertebral disc between these vertebrae. At this time a diagnosis of possible early Pott's disease was entertained.

When I first saw her she complained of severe pain in her back *only* in the region of the first and second lumbar vertebrae. In this location there was tenderness to pressure on the right side of the spinous processes and no where else. She did have a mild left lumbar scoliosis. But

I discounted this as the likely cause of her pain because scoliosis in children is almost never a painful deformity. The roentgenograms, both

FIG. 2. Note the absorption of the upper margin of the right lamina of the second lumbar vertebra.

those which I had taken and all previous ones, showed an unusual lesion. There was an excavation in and an absorption of part of the right lamina of the second lumbar vertebra (Fig. 2), which had been missed by her previous physicians. I was uncertain of the exact diagnosis but advised an exploratory operation believing that there probably was a neoplasm which was eroding the lamina.

At the operation I found a cherry-sized red, granular mass between the laminae of the first and second lumbar vertebrae on the right side with erosion of a part of the lamina of the second lumbar vertebra. I removed this mass and then did a hemilaminectomy on the first and second lumbar vertebrae to allow inspection of the dura, and to make sure that I had left none of the diseased tissue. The pathological diagnosis was osteoid osteoma. The patient has been completely relieved of her backache and is rapidly regaining full function of the spine.

In retrospect the error committed here lay in the failure to recognize a small but quite definite laminar erosion in the second lumbar vertebra. In this case, as in other osteoid osteomas, the triad of symptoms and signs was present. The pain and tenderness and the roentgenographic findings were all located in the same area.

I wish now to report a case which has many interesting features, one which, in point of difficulty in differential diagnosis, lies between the two cases previously described:

M. N., ten years old, began to experience some pain in the front of his left ankle in the summer of 1942. I was consulted in September, 1942. At that time he had a mild circumferential swelling of the ankle and a mild limp. He pointed to the front of the ankle as the site of his pain, and in this region he had exquisite tenderness to pressure. The localization of the pain and tenderness led me to *suspect* an osteoid osteoma of the astragalus, although the swelling of the ankle and the limitation of the lesion to one joint compelled me to keep in mind the possibility of a tuberculous arthritis. An *x*-ray film showed what I believed was a small area of rarefaction in the neck of the astragalus near the subastragaloid joint. I advised an operation which was refused. I next saw the patient one year later, in October, 1943. During the intervening time the pain and swelling had increased and the boy could no longer bear weight on the affected foot. He had been immobilized without relief. He had had an arthrotomy at another hospital where nothing but congestion of the synovia of the ankle joint had been found. Unfortunately, the exploratory incision had been made over the anterolateral aspect of the ankle so that the body but not the neck of the astragalus had been exposed, and hence the lesion was missed.

When I saw him in October, 1943, there was a very marked swelling of the ankle including both sides of the heel cord. The pain was, however, located over the neck of the astragalus. There was to be sure generalized tenderness, but this was most marked and very acute

in the region of the neck of the astragalus. New *x*-ray films (Fig. 3) showed an unmistakable lesion in the neck of the astragalus, not revealing the front of the body and the neck of the astragalus. There came into view on the superior surface of the neck a circular area,

Fig. 3. There is an oval area of rarefaction within the substance of the neck of the astragalus near its upper margin. There is a narrow zone sclerosis.

in the lower part of the neck as I had imagined in 1942, but in the upper part. There was a circular, sharply-defined rarefaction about three-eighths of an inch in diameter. The process appeared to be within the substance of the cancellous tissue just below the superior surface of the astragalus.

There appeared now no doubt about the nature of the lesion and reoperation was urged which was performed by me on January 27, 1944. An incision about three inches long was made on the anterior surface of the ankle. The incision was directly over the neck of the astragalus and lay along the line between the tendons of the extensor hallucis longus and the long extensors of the toes. Much granulation tissue was found in the angle between the tibia and the foot. This was excised exposing the anterior capsule which was greatly congested, thin and frayed out. The segment of the capsule in the operative area was removed about a half inch wide, of roughened congested bone denuded of periosteum. This area was sharply circumscribed. On either side the bone appeared normal. The area of diseased bone in the neck of the astragalus corresponded to the region of the pain, tenderness and roentgenographic findings. It was completely excised. A check-up *x*-ray film (Fig. 4) showed that all of the disease had been removed. A subsequent pathological examination confirmed the diagnosis of osteoid osteoma. The relief from the pain was dramatic, for when the boy awoke from the anesthesia he volunteered the information that he was free of the pain. He has not had any pain since then.

COMMENTS

The problem in this patient was, from the point of view of diagnosis, confused by the presence of a generalized swelling

and sensitiveness of the ankle with pain on attempted weight bearing. This condition limited to a single joint naturally almost any other kind of an arthritis without an abscess and without systemic disturbance splinting of the affected joint

FIG. 4. Check-up *x*-ray film made at the time of operation to assure the complete removal of the central nidus of osteoid tissue.

inclined one to the diagnosis of an arthritis, probably tuberculous. The opinion was strengthened by the equivocal *x*-ray findings in the early period of the disease, and more specifically by the general haziness of the joint, which is one of the earliest roentgenographic changes in tuberculous arthritis. The absence of evident bone destruction or erosions of the articular surfaces of the ankle joint could be accounted for by the existence of a synovial lesion which had not yet invaded bone or had involved it so little that there was not sufficient destruction for roentgenographic visualization. On the other hand immobilization of the ankle and freedom from weight-bearing had given no relief whatever. In a tuberculous or almost uniformly reduces the pain. In addition the boy's complaint was always referred to one area, that of the neck of the astragalus. The greatest tenderness was found in this location. The tenderness in this disease, as in acute osteomyelitis, must be tested for very gently and deliberately by slowly palpating one small area after another. In this way only can the exact site of the lesion be identified. The persistent localized pain and tenderness in this case should, therefore, have led to the suspicion of a lesion other than a tuberculous arthritis, and impelled further and repeated *x*-ray studies in several different planes before an arthrotomy was undertaken.

SUMMARY

There is here recorded the detailed history of an instance of an osteoid of the neck of the astragalus in a child. In the early stages of the disease there was such a marked swelling of the ankle extending up along the heel cord that the clinical appearance suggested the diagnosis of a tuberculous arthritis. Immobilization gave no relief, and an arthrotomy did not disclose the real pathological process. The persistence of the greatest pain and tenderness in the anterior portion of the ankle in the region of the astragalus, and the final appearance of a localized rarefaction in the neck of the astragalus led to the correct diagnosis, and the surgical cure of the disease. The specific purpose of this report is to direct attention again to the disease, osteoid osteoma, which is fairly common. It is a lesion with a triad of characteristic subjective and objective symptoms. Osteoid osteoma will be recognized more frequently if these symptoms and the possible existence of this disease are kept in mind.

Treatment of secondary malignancy of bone is palliative. Support and fixation should be used for fractures; irradiation, opiates, nerve blocking, chordotomy or rhizotomy for the pain.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

SURGICAL AND MEDICAL MANAGEMENT OF TUBO-OVARIAN ABSCESS*

CASE REPORT

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THIS case is of interest not only from the surgical aspect but from the medical as well. While the patients recovery was due to surgical interference, still one cannot deny that medical management made it possible to bring the patient to surgery. With the progress of the medical science, it might be that new combinations of drugs will be used in combating disease, but the fundamental idea of preparing the patient medically to build resistance and lessen danger of unavoidable operation will remain the same.

The drugs used, S.U.M. 36, is a symmetrical urea of M-benzoyl-M-amino-benzoyl-1-amino-8-naphthol-3:6-sodium sulfonate (1 per cent sterile solution) and S.U.P. 468 is the symmetrical urea of p-benzoyl-p-amino-benzoyl-amino-naphthol 4:6:8 sodium sulfonate, 1/10 per cent. This drug stands chemically somewhere between tryponosomiasis drug, called Bayer 205 and the sulfa drugs. S.U.P. 468 is another predecessor of the sulfa drugs. The effective dose is very small and a toxic dose is very large. Both of these drugs have been devised by J. E. R. McDonagh in London and manufactured by British drug houses. The adrenal cortex was used to stop the leakage of the fluids from the capillaries and to strengthen the musculature of the patient, including the heart muscle.

CASE REPORT

Miss McE., aged thirty-five, entered Wesley Memorial Hospital on Saturday, April 24, 1943, acutely ill. Her illness started one week previously by an elevation of temperature. The next day she had chills and fever. In the middle of the week, Wednesday, a physician was called and after examination made a diagnosis of an acute condition of the abdomen and prescribed sulfanilamide. On Thursday, the patient passed some blood clots from the vagina. On Friday, she began to have violent pains over the abdomen.

The patient weighed 126 pounds; her height was 5 feet 4½ inches. Her temperature was 104°F. and blood pressure 127/90. The pulse was of good volume, rhythmic and 84 to the minute.

Her last menstrual period was April 10th; the previous period was at the regular time in March. Both menstrual flows were of three days' duration. The onset of menstruation was at thirteen years of age, once per month, of three days' duration, using two to three pads per day. She never had dysmenorrhea.

An inventory of symptoms was negative except for weakness. When twenty years of age she underwent an appendectomy. The patient cannot recall any childhood diseases. She had no venereal diseases and no trauma. As to her habits there was nothing worthy of note except that the patient was an expert equestrian.

The patient's grandmother was a Cherokee Indian. Her mother was living and well. Her father at the age of seventy was killed accidentally. The patient had two healthy sisters and there was no history of serious diseases in the family.

General examination of the patient revealed a rigid abdominal wall, pronounced meteroism, and a mass in the pelvis. Bimanual examination disclosed tense, right adnexal enlargement, the size of a large closed fist. The uterus was sinistroposed and the left adnexa was not palpable.

* Read before the Chicago Gynecological Society, October 15, 1943.

The patient's temperature varied between 101 and 103°F. Red blood cells were 4,400,000, hemoglobin 80 per cent, leukocytes 11,800; polymorphonuclears 84 per cent, lymphocytes 16 per cent. Blood serum Kahn reaction was negative. Sedimentation test was rapid. There was no growth in blood culture. Ashheim-Zondek test was negative. Urine: Specific gravity 1.018; twenty-four-hour output over 2,700 cc.; albumin 30 mg., occasional red blood cell, four to five white blood cells, no casts. In subsequent days the albumin in the urine disappeared. A cervical smear was negative for gonococci.

Sulfathiazole was given to the patient and 2,000 cc. of 5 per cent dextrose intravenously. The fluids were repeated April 25th, 26th and 27th. A physiological salt solution was added. Prostigmine, 1:2000, was given every four hours. Sulfathiazole was discontinued due to toxic effect. On April 29th, an *x*-ray of the abdomen was taken and some gas in the course of the gastrointestinal tract and the soft shadow in the pelvis not sharply demarcated were detected. The patient continued to receive intravenous fluids but in spite of this treatment she became alarmingly dehydrated. We presume the dehydration was caused by a leakage of fluids through the interspaces between the epithelium of the capillaries.

On May 1st, 250 cc. of blood plasma was given intravenously and S.U.M. 36 and adrenal cortex intramuscularly were given. On May 3rd, her temperature dropped to 99.8°F. but at evening it rose to 102.9°F. and continued to be elevated the following days. On May 9th, yellow grayish pus was aspirated with a syringe from the cul-de-sac, after which a semilunar cut was made on the posterior fornix with scissors. The peritoneum was opened and about one-half glass of pus was evacuated. A rubber tube was inserted and attached with a silk stitch to the fornix. Our expectations that the patient's temperature would drop were not realized; the temperature continued to be elevated. After operation 500 mg. of cevitamic acid was added to the intravenous fluids.

On May 22nd, the red blood cell count showed 3,600,000, hemoglobin 85 per cent, leukocytes 7,600. On the same day injections of 2 mg. of S.U.P. 468 were injected and 250 cc. of blood plasma and reticulogen was injected.

On May 25th, 250 cc. of blood plasma again was given. On May 30th, feeding with dexin was begun. The patient's temperature continued to be from 101 to 102.9°F. She lost over twenty pounds in weight and was very weak and apathetic.

On June 2nd, under cyclopropane anesthesia the posterior fornix and peritoneum were opened and enlarged through the old scar. The index finger was introduced and the uterus was found pressed to the left. The left adnexa could not be outlined. The right ovary was enlarged to the size of a goose egg and was soft and bulging. With the finger the ovary was pierced to make a road for approach to the tube. Sanguineous purulent content with decayed ovarian tissue were evacuated. No bleeding took place evidently due to thrombosis of the ovarian artery. The finger then approached the thick, tense wall of the tube which was enlarged to the size of a closed fist. Sliding along the palmar surface of the pointed index finger pressing against the tube wall, a long curved scissors was introduced and by pressure the tube was pierced and the opening enlarged. Pus flowed in abundance. A rubber tube was introduced and the wound packed loosely with gauze. On the way of reaching the ovary and tube there were many string-like tense adhesions running in different directions.

On the day of operation the patient's temperature was 102.8°F. The next day it rose to 105°F. After two days it dropped to 100.2°F. and for the following ten days it fluctuated between 99 and 101°F.; for the eleven subsequent days the temperature was between 99 and 100°F. On June 23rd, the temperature dropped to normal and on June 29th, the patient was discharged.

The patient was seen several times after leaving the hospital. On her visit November 22, 1943, the uterus was found in the midline, slightly enlarged, symmetrical, firm, smooth, not tender, with limited movability. The left adnexa was normal. The right adnexa was enlarged, about the size of two finger width. The patient had regained her normal weight.

The last time the patient was seen and examined, April 24, 1944, a slight enlargement of the right adnexa was found. The patient had had no pains in the lower abdomen from September, 1943, up until the present time. She does secretarial work and at no time was absent from her duties.

SARCOMA OF THE SMALL INTESTINES

CASE REPORT

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SHREVEPORT, LOUISIANA

SARCOMA of the small intestines is a rare condition. Ralleston reports four cases in 18,000 necropsies, Schlesinger seventeen in 42,000 necropsies and Staemler thirty-three in 54,000. Unless there are duplications of records, forty-four cases of sarcoma were encountered in 114,000 autopsies. According to the literature, the condition is rarely diagnosed before death unless an operation is performed for acute obstruction or a palpable tumor is responsible for the operation. Therefore, forty-four cases in 114,000 autopsies or .0003 per cent is a fairly accurate estimate of occurrence of sarcoma of the small intestines.

In 2,200 cases of intestinal cancer there was one case of sarcoma. Nickerson and Williams reviewing 11,206 autopsies over a period of forty years report ten cases of malignancy of the small intestines, two of which were sarcoma. Rowley reports that in 1,500 laparotomies at the Hartford Hospital there was only one sarcoma of the small intestines. Gotten of Memphis found four sarcomas of the small intestines in a review of 20,000 case records. Up to 1939, Hartman had found only twenty-seven cases of sarcoma of the small intestines in the Mayo Clinic's records. From 1924 to 1939 inclusive, a period of sixteen years, 217,468 patients were admitted to the Shreveport Charity Hospital (a state institution). According to the records, there were three cases of sarcoma of the stomach, one sarcoma of the mesentery and small intestines, one of the rectum and one diagnosed as sarcoma of the small intestines alone, all discovered either at exploratory operation or autopsy. This latter case was a white male infant, age four, brought in acutely ill with distended abdomen and a mass in the upper right quadrant attached to the liver. Death occurred following exploratory laparotomy. Most writers insist that sarcoma of the small intestines, like carcinoma, is more prevalent in the duodenum. However, Smaller who reviewed the records of 13,036 malignancies of the gastrointestinal tract, found thirteen sarcomas, six of which were in the jejunum and none in the ileum. Of the 39,444 admissions to the Edward Hines, Jr., Hospital, the one sarcoma recorded was in the jejunum.

Types. According to Ewing, a sarcoma may rise from any mature mesoblastic tissue. In the small intestines this includes the submucosa, subserous connective tissue and the muscular coats. "Histologically this accounts for the finding of fibrosarcoma and leio-myo sarcoma as the most frequent types of sarcoma of the intestines." Adenosarcoma, lymphoblastoma or lymphosarcoma, liposarcoma and sarcoma engrafted on the various types of benign tumors found in the intestines might be encountered.

Symptoms and Diagnosis. The diagnosis of sarcoma of the intestines like all diagnoses is predicated upon the symptoms. Unfortunately, the symptoms are inconstant, variable and at times bizarre. If the tumor is situated in the duodenum, there may be nausea, vomiting and other gastric disturbances. If the tumor arises from the submucosa and is projected into the lumen of the bowel, obstruction either partial or complete with the accompanying symptoms are present. However, when the tumor arises

from the muscular or subserous coats, the tumor projects out into the abdominal cavity and presents no symptoms other than those usually encountered in various tumors of the abdomen not attached to the bowels. In some cases there may be a dragging or pulling that might suggest bowel attachment, but this same symptom is not infrequent with other abdominal tumors. Constipation, diarrhea or even bloody or mucous stools may occur but are inconstant. If one is hot on the scent of this condition, certain *x*-ray signs such as dilated intestines, malpositions, etc., may be read into the picture; but on the whole, roentgenograms are not very helpful in diagnosing sarcoma of the small intestines. In reviewing a number of case reports in the literature, the one constant symptom or sign was leucocytosis. The total white counts would range from 15 to 20 thousand with a rise of polymorphonuclears from 80 to 95 per cent. Why this occurs I am not prepared to answer. Perhaps it was that the great majority of these patients were operated upon because of symptoms of obstruction. However, the case which I shall report exhibited repeatedly acute fever and leucocytosis without any evidence of obstruction at any time. We are all aware that leucocytosis alone is nothing on which to hang a diagnosis of sarcoma of the small intestines. This is merely mentioned as of passing interest.

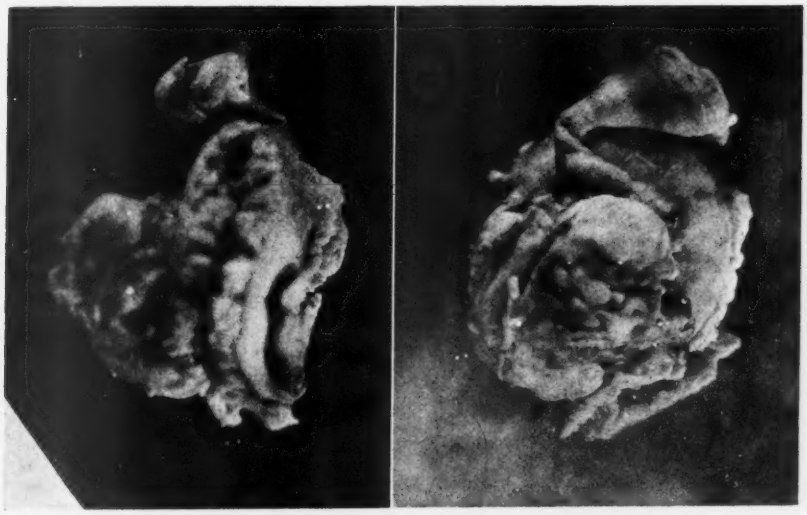

Fig. 1. Fig. 2.

Fig. 1. Mucosal aspect of tumor.
Fig. 2. Surface of tumor made by section.

Prognosis. The prognosis is good in sarcoma of the small intestines, at least much better than in carcinoma of the small intestines. This is because the tumor is easily removed by resection of the bowel, and when metastases do occur, it is very late in the course of the disease. Nickerson and Williams (from the Mallory Institute of Pathology, Boston City Hospital), reporting in detail on ten primary malignancies of the small intestines (eight carcinoma and two sarcoma), found metastases in seven out of eight carcinomas and no metastases with the two sarcomas.

CASE REPORT

Miss C. B., sixty years old, called my attention to a freely movable hard tumor in the left iliac region while I was attending her for an attack of influenza six months previous to the operation. She had noticed the tumor about one year previous to the influenza attack, but it had been producing no special symptoms. The tumor apparently did not grow larger during the six months period previous to the operation. However, she had unusual attacks of hyperpyrexia with leucococytosis whenever she walked a few city blocks. Rest

in bed for a few days would cause her to become fever-free with a return to normal blood counts. The urine was always negative. The bowels moved regularly without medication. There was no loss of weight nor no nausea or vomiting. The heart and lungs showed no pathologic condition; the blood pressure was 130/70. A slightly ptosed left kidney could be felt through a very thin abdominal wall.

The tumor which seemed upon palpation to be the size of the fist of a very large man, was freely movable in the lower left abdominal region. There was very little pain when the tumor was manipulated. *X*-ray of the gastro-intestinal tract by a competent radiologist was reported negative as to any evidence that the tumor involved any part of the intestines. The day she was operated upon her blood picture showed some anemia (red blood count 3,970,000, hemoglobin 70 per cent, leucocytes 7,800, small leucocytes 28, neutrophiles 72).

A diagnosis of possible pedunculated fibroid of uterus was the preoperative diagnosis. In fact, so sure was I of my diagnosis, that the abdomen was opened with the patient in the Trendelenburg position. But when I put my hand in the abdomen the tumor was not there. However, I soon found it in the upper abdomen with some slight omental adhesions, and the diagnosis burst before my eyes. The tumor, about 7 cm. in diameter, was jutting out from the walls of the upper portion of the jejunum. The tumor with several cm. of healthy intestines was removed, an end-to-end anastomosis performed, 75 gr. of sulfanilamide scattered over the line of sutures and the abdominal cavity and the abdomen closed without drainage. One blood transfusion, intravenous sulfanilamide, glucose and saline and thiamin chlorid were administered postoperatively. She made an uneventful recovery and was removed to her home on the tenth day after the operation.

The tumor was of the cystic variety, not infrequently described by pathologists, and involved the muscular coat of the intestines. There was a small concaved button-like prominence inside of the bowel, but not large enough to interfere with the flow through the lumen. The pathological diagnosis was low grade leiomyosarcoma of the intestines.*

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* The patient is still in good condition fifteen months after the operation. Pathological diagnosis by Dr. W. R. Mathews, Pathologist of the Shreveport Charity Hospital.

HEMATOSALPINX IN A FEMALE INFANT

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THIS case is presented in order to illustrate a condition which should be in the mind of every surgeon operating upon an acute condition of the abdomen in a female infant. Although fortunately rare, its association with periappendicitis is apt to cause the underlying pathological process to be overlooked unless a thorough examination of pelvic viscera is done in every case.

CASE REPORT

A thirteen month old female infant was admitted to the hospital with the diagnosis of acute condition of the abdomen, probably acute appendicitis. The past history revealed no previous illnesses, and father and mother were living and well. She had no brothers or sisters. The baby was delivered with low forceps following an episiotomy, after mother had received adequate prenatal care. The puerperium was uneventful. The infant's health had been excellent up until the present illness.

The chief complaints were elevated temperature, abdominal cramps, and history of gastrointestinal upset of thirty-six hours' duration. The mother stated that the baby had what she considered "intestinal flu" three days ago. The attack was accompanied by loss of appetite, temperature elevation to 100.4°F., numerous watery stools, and vomiting of part of the feedings. This subsided on the first day. The following day the baby had no bowel movements, appeared restless and feverish, and cried as though in pain. She vomited once. The day before the writer was consulted, the infant had two enemas with only hard, constipated, marble-like stools without appreciable improvement. She was seen at 1 A.M. of the day of admission, when it was noted that her abdomen was tense and rigid. The right leg was kept flexed on the abdomen. Extension of this leg caused apparent pain. Immediate hospitalization was advised.

Physical examination showed a well developed, well nourished child of thirteen months. Fontanelles were under no pressure. The pupils reacted well. There was no evidence of rhinitis and the throat was clear. The tongue was slightly dry. No râles or adventitious sounds in the chest were heard. The heart sounds were of good quality with no murmurs. The abdomen showed tenderness and spasm with rigidity, more marked on the right, slightly below McBurney's point. The right leg was semiflexed, and extension caused the child to cry out with pain. There were no evidence of masses on rectal examination, but the child was apparently tender in both vaults.

Consultation was held with two staff members and consensus of opinion was that child had acute appendicitis, and immediate surgery was advised. Blood count taken on admission showed hemoglobin of 100 per cent; red blood cells of 5,210,000; white blood cells 18,750; polymorphonuclears 54 per cent, lymphocytes 42 per cent, and large monocytes 4 per cent. Color index was 9 per cent. Seven hours later repeat blood count showed 18,050 white blood cells, 70 per cent polymorphonuclears, 18 per cent lymphocytes, 4 monocytes, and 8 eosinophiles.

Twelve hours after admission to the hospital the baby underwent surgery. Under ether anesthesia a right rectus incision was made and the muscle retracted medially. When the peritoneum was opened about 20 cc. of brownish, serous fluid exuded. The appendix delivered without difficulty and was removed by clamp, tie, carbolic knife, and alcohol. Mesentery to appendix was suture ligated and the stump attached to the tab. Exploration of the pelvis revealed a semi-circular mass, hard, bluish-black in color, which was identified as the right tube and ovary. This was delivered into the wound. The tube and ovary were clamped at the fundus, removed, and the fundal end suture ligated and peritonealized. Examination of the left tube and ovary, and uterus showed them to be normal. The wound was closed in the usual manner, without drainage.

The abdomen contained about 20 cc. of brownish serous fluid which was odorless. The appendix showed considerable peri-appendiceal injection, without adhesions. The right tube was markedly swollen and gangrenous. The right ovary was swollen, under considerable pressure, and filled with blood.

The pathological report was as follows: Gross examination: Specimen consists of (1) an irregular mass, measuring 3.5 by 3.3 by 2 cm. which consists of a tortuous tube, and a smooth ovary, having a purple red surface. Section through the ovary reveals nothing which can be recognized grossly as ovarian tissue. The appearance of the whole is that of firm red blood clots although beneath the capsule some small cystic areas can be made out. The tube also shows only thick blood clot obliterating the structure and this tube measures from 5 to 9 mm. in diameter. (2) An appendix 4.5 cm. in length and 6 to 8 mm. in diameter. There is considerable congestion of the greater part of the serosa which is dull. Section shows considerable thickening of the walls and a little fecal material in the lumen. Gross diagnosis: (1) Infarction of the tube and ovary, hematosalpinx; (2) acute peri-appendicitis.

Microscopic examination of the tube and ovary both shows only a delicate fibrous loose stroma with few recognizable typical structures, since both are so engorged with free blood as to obscure the underlying structures. The appendix shows a slight fibrous thickening of the walls with few lymphocytes and rare polymorphonuclears. The surface is covered by a layer of fibrin and polymorphonuclears. Pathological diagnosis: (1) Acute infarction of tube and ovary, hematosalpinx; (2) acute peri-appendicitis.

It is difficult to be dogmatic as to the cause of the infarct. It is possible that an embolus was formed in the vessels supplying the tube and ovary due to the contiguity of these structures to intestine altered by gastroenteritis. Because of the relative infrequency of an infarct of the tube and ovary in infancy, the correct preoperative diagnosis will seldom be made. This should be of little concern, however, as the condition is acute, and early surgical intervention is essential.*

SUMMARY

A case of infarct of the tube and ovary with peri-appendicitis in a thirteen month old female is presented, showing the necessity of a thorough examination of the pelvic viscera in the female infant with acute appendicitis.

* The patient made an uneventful recovery and four months later was eating and sleeping well, had gained in weight, and there has been no history of gastrointestinal or pelvic disturbance since the operation.

Bookshelf Browsing

JAMES BOLTON (1812–1869)

EARLY PROPONENT OF EXTERNAL SKELETAL FIXATION

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THE history of medicine contains numerous examples of identical discoveries made independently by different individuals.[1] In some instances the two discoveries were made almost simultaneously while in others considerable time had elapsed between them. This is no less true in the history of orthopedic surgery. Lister's operation for the fracture of the patella in 1877 was successfully performed sixteen years earlier by Cooper, an American, using alcohol as an antiseptic. J. H. Rodgers, another American, successfully wired an ununited fracture of the humerus in 1827, forty-six years before this method was used for fracture of the mandible by Thomas. The method of drilling the bone ends to hasten union, though introduced by Bohler, of Vienna, after the last war, was described eighty years previously in Brainard's essay published in New York.[2]

The treatment of fractures by external skeletal fixation is a relatively recent development in orthopedic surgery. Nevertheless, we find a rather complete description of this method by James Bolton as early as 1864 with a report of a patient treated in 1853.

Bolton presented his method in the Confederate States Medical and Surgical Journal while he was a surgeon in the Confederate States Army.[3] At the time his "New Method of Treating Ununited Fracture of Long Bones" appeared, he was serving as surgeon in charge of the 3rd Corps Receiving Hospital. His work here offered ample opportunity to observe and become disturbed by the high mortality accompanying fractures of the long bones.

There is no evidence that James Bolton was at any time particularly interested in orthopedic surgery. A native of Savannah, he was taken to New York during his childhood, received his A. B. from Columbia in 1831 and his M. D. from the College of Physicians and Surgeons in 1836. After studying the diseases of the eye and ear with Dr. John Kearney Rogers and serving some time as clinical assistant to Dr. Valentine Mott, he began to practice in Richmond. In 1842, his "Treatise on Strabismus, etc." appeared. It contained a description of "the steel hook with its guard" which Bolton invented for the purpose of decreasing the drying of the eye and the temptation to wink during the operation. He also reported eight successful cases involving its use. His contribution was well received both in this country and abroad.

With the discovery of anesthesia, James Bolton became interested in its use. In 1851, he reported his experience with ether in operations on hemorrhoids. An article appearing in 1852 under the title "A Test for the Safety Point in Anesthesia" described his work with chloroform. This was a very pressing question at the time, since physicians were very much concerned about the safety of the new anesthetic agents. Bolton's work did much to encourage their use.

Moreover, he occupied a leading position in his profession. In addition to editing a medical journal and serving as chairman of important committees of the American Medical Association in 1858, he was president of the Medical Society of Virginia.[4]

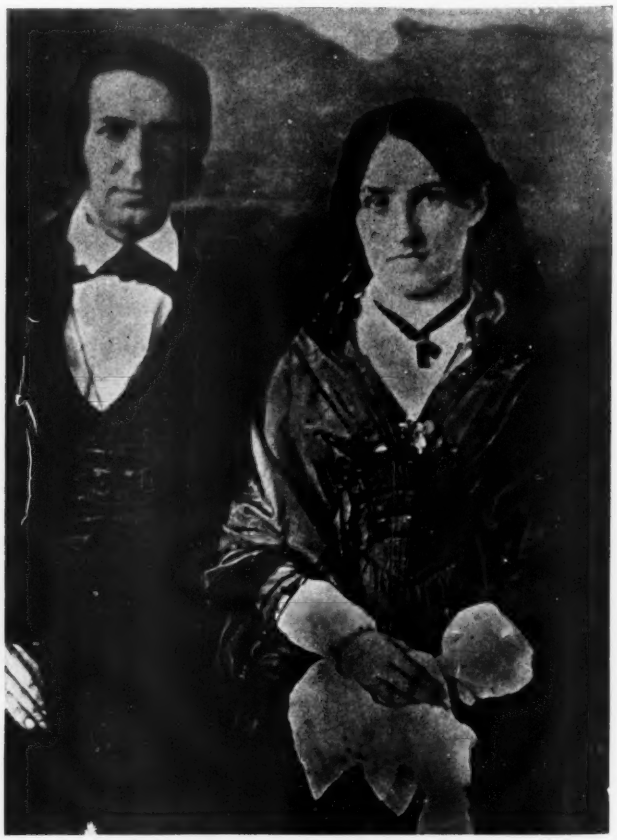

Fig. 1. James Bolton, M.D. and his wife, Anne Maria Harrison Bolton.

James Bolton was fifty-one years of age when he left a lucrative practice to serve as a surgeon in the army. Nevertheless, he carried into his military work the energy and enthusiasm for his calling that was so evident in his earlier civilian life. His letter dated May 29, 1864 to Wm. A. Carrington, Medical Director of the Hospitals of Richmond, is revealing not only of the times, but also of the man.[5] In it he writes:

"Sir:

"Being unable to communicate with the proper medical officer in the field I have to state to you my present condition. There are at this post eighty-three persons including attending surgeons, sick & wounded officers and men, and attendants such as cooks, nurses, etc. For these I now have scant rations for two days. This whole country has been drained of provisions so that the inhabitants have not a sufficient supply for domestic consumption. My small stock of stimulants is exhausted and I have but a few articles of medicine and those I am compelled to use sparingly. Under these circumstances it is not surprising that my rate of mortality is frightful and unless some relief be obtained all must die who have not strength of constitution to bear up against these adverse circumstances. I am utterly unable to give relief and can only stand by and see my men sinking for lack of medicine and sustenance. The picture which I have drawn of the condition of my hospital is but a counterpart to those of the other hos. corps in my neighborhood. In all these hospitals subsistence is required for about five hundred men. A considerable number of the sick and wounded will bear transportation and many

of the hospital attendants are able bodied men who ought to be with their commands.

"I therefore respectfully urge upon you to give your *immediate* attention to this subject. I respectfully suggest that a train of twenty ambulances and an equal number of wagons be forwarded to this post as promptly as possible sending by them subsistence sufficient to relieve our pressing necessities. On its return this train might be laden with the sick and wounded capable of bearing transportation. By two trips nearly all could be carried off and a large number of able bodied men could then be returned to their commands and the surgeons now almost uselessly employed could be returned to their respective posts of duty.

"By your prompt attention to the subject of this communication you will perform an act of humanity and greatly oblige

"Yours very respectfully,
"James Bolton, Surg., P.A.C.S.
"in chg. 3rd Corps Receiv'g hospl."

Bolton was not simply a civilian doctor in a military organization. He quickly grasped the fundamental principle that "In military service, it is not only the best method of treatment that must be considered, but one that permits treatment of a large number of casualties in limited time."[6] This is clearly exemplified in his evaluation of a vulcanite interdental splint which was developed during the war for treatment of fracture of the jaws by James Baxter Bean,[12] a Southern dentist. Bolton writes of Bean's device, "The interdental splint . . . appears to me to approximate perfection as nearly as we are likely to reach. The means of preparing it, however, are not always at hand. The splint hereafter described (using gutta percha) has the advantage of greater simplicity, of fulfilling the indications in a similar though less perfect manner and may be always within the reach of the surgeon."[7] It must be remembered that Bolton had spent the major portion of his professional life in civilian practice. Nevertheless, at the age of fifty-one he was sufficiently young and flexible to adopt wholeheartedly the viewpoint of the military surgeon.

It is this adaptibility together with the humanity and professional integrity expressed in the letter to Carrington that probably forced his concern with the

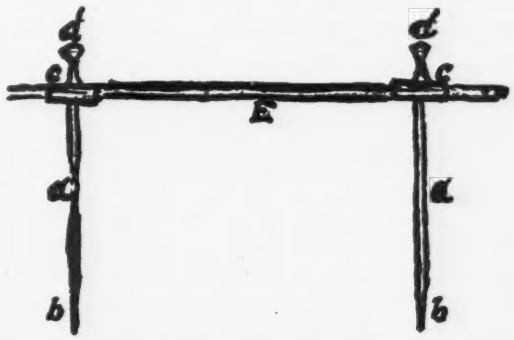

Fig. 2. James Bolton's "Instrument." "My observations," Bolton wrote, "on cases of gun-shot wounds of the thigh, with fracture of the bone, have impressed me strongly with the unsatisfactory character of the ordinary methods of treating them." After listing the many difficulties which accompanied these methods he stated that "Amputation is only an exchange of risk of death by exhaustion, for risk of death by shock." He then asked attention to his new method by which he proposed "to secure co-aptation, adaptation and quietude." The method which Bolton used in 1853 is described thus:

"Two steel rods, *a*, three inches in length were each cut at one end into a screw, *b*, three-eighths of an inch long. To the other end was attached at right angles, a hollow cylinder, *c*, having on its upper surface a screw, *d*. A steel rod, *e*, five inches long, completed the instrument. The patient was anaesthetized, and powerful extension was used until the limb was brought to the proper length. The point of a scalpel was then thrust down to each fragment, one inch from the extremity, and a hole was drilled in each as far as the medullary canal. In these holes the rods, *a*, were screwed. The ends of the bone were then adjusted by pressure upon one rod and by traction upon the other. When adjustment was complete, the cylinders, *c*, were in a line with each other. The rod, *e*, was then passed through them and secured by the screws, *d*. This rod was outside of the integuments, and was of necessity parallel with the shaft of the bone. The only motion then possible was a rotary one upon the screws. This was prevented by straight splints upon opposite sides of the thigh. The same thing might have been accomplished by applying another instrument at right angles to the first."

Bolton recommended that his instrument be applied to other long bones and to the lower jaw. (From *Confederate States Medical and Surgical Journal*, Vol. 1, No. 4, pp. 55–56, April, 1864.)

problem of fractures. His ingenuity suggested the solution which he presented in his article.

The fact that we do not speak of a Bolton splint today is sufficient proof that his suggestion was not immediately embraced by an eager profession. Bolton himself indicates the reason for this in a footnote to the article describing his instrument. He states:

"It may be objected that by this method a simple fracture may be converted into a compound one, but a careful consideration will lead to the conviction that this result ought not to occur. In the case of gun shot wound the fracture is already compound."[3]

A glance at the surgical practise of Bolton's era will enable us to understand why this method was not adopted. W. W. Keen, the Philadelphia surgeon who served with the Union Army, described this period thus:

"A comparison between the danger of immediate death in battle or later from wounds in the Battle of Gettysburg, and of the danger of death from the surgery of Civil Life in the '60's, shows that it was seven times safer to fight all through the three days of Gettysburg than to have an arm or a leg cut off or to be run over and suffer a compound fracture of the leg and be treated in a city hospital, with the septic surgery we then practiced!"[1]

In these times the foremost surgical opinion held immediate amputation to be the best procedure for compound fractures of the long bones. Surgeons were reluctant to try the ordinary conservative methods at hand. Bolton's method must have seemed extremely daring and equally dangerous. In such a situation we can understand the failure of Bolton's method to take hold.

Unfortunately, as often happens in the history of science, the seed of James Bolton's new concept fell on the barren soil of pre-Listerian surgery. It could not possibly germinate at a time when a surgeon as outstanding as S. D. Gross would begin an operation by giving "a last fine touch to his knife on his boot—even on the sole—and then at once use it from the first cut to the last."[8]

Strikingly enough, as Bick in his "Source Book of Orthopaedics" points out, it was not proved until the period following the last war with the work of Bohler "that the traditional fear of infecting bone was baseless in the presence of adequate asepsis."[9]

Shaar and Kreuz in their recent "Manual of Fractures" speaking of Bohler's influence in this direction say, "His persistent efforts and successes were chiefly responsible for the gradual elimination of pin phobia held then by many surgeons, and still retained by some today."[10]

If this hesitancy is still retained today, we can feel no less than admiration for Bolton's intrepidity and yet fully understand why it was not adopted by the surgeons of his day.

The last issue of the Confederate States Medical and Surgical Journal appeared in January, 1865, and the Confederacy collapsed three months later. James Bolton's "New Method" was buried with the journal for which he wrote and with the cause which he served.

Asepsis was introduced by Von Bergmann and formulated and developed by Simmelbusch in 1892, as a substitute for antisepsis.[11] In 1897, Clayton Parkhill, an American surgeon, introduced a new apparatus employing rigid fixation in the treatment of fractures of long bones.[10] This contribution being nourished by modern technical as well as medical science is still in the process of development today.

However, the story of James Bolton is not without meaning. It suggests that a study of the history of medicine must reveal a mine of prematurely conceived ideas. These ideas may require only transplantation into the more fertile environment of our modern scientific period

in order to bring them to the full maturity of practical utility.

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One requisite of a good stump is that the severed muscles receive a new insertion at the stump end. Redundant muscle tissue is useless and makes the stump more difficult to fit and prone to chafe. It is very important that cut ends of muscles or their tendons be grouped about the end of the bone and fixed to the periosteum and fascia or to each other so that they will not retract and leave the bone exposed beneath the skin after healing.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

Selected Book Reviews

AN APPRECIATION*

THE appearance of the seventh edition of Flagg's "Art of Anesthesia,"* twenty-seven years after the first edition had made its debut in the medical world, is sufficient testimonial of its worth and of the esteem in which it is held by the profession.

In 1916, on the eve of America's decisive entry into the first world war, the book came opportunely to meet the requirements of the great army of young medical graduates and others who were preparing for the surgery of the titanic conflict that was near at hand. Though not written from the military viewpoint, the book served an admirable purpose as scientific groundwork upon which the student could build a more comprehensive knowledge of the art of anesthesia as this applied to its many fields and phases.

Dr. Flagg's now classical text was unique from the start, not only because it condensed the lessons of the author's vast and varied experience as an anesthetist, teacher and consultant, in the most important hospital centers of surgical experience in New York, but because it was essentially a personal work, largely the work of a pioneer and a contributor to the evolution of anesthesia as it has so marvellously developed in the United States, the country of its real and historic birth. Besides, it was a book which dealt with fundamental principles in the physiological pathology of respiration and circulation, principles which govern the applications and technics of anesthesia and anesthetics, regardless of the birth and decline of new drugs and new methods.

How experience in anesthesia gathered in civilian practice is readily applied to the exigencies of war is shown by the attention and praise given to Dr. Flagg's lectures and demonstrations by groups of Army surgeons when the War Demonstration Hospital of the Rockefeller Institute for Medical Research was opened in 1917.

It is, no doubt, gratifying to Dr. Flagg that he can again render service to the profession after the lapse of over a quarter of a century,

*The Art of Anaesthesia. 7th ed. By Paluel J. Flagg. Philadelphia, 1944. Price $6.00.

by offering to the medical public a seventh edition of his "Art of Anesthesia" which, in its present revised form, should prove as timely and valuable an acquisition to the medical services of the battling American armies of World War II, as the first edition helped to train the anesthetists of the American Expeditionary Forces in 1917 and 1918.

Again, Dr. Flagg, animated by an altruistic and patriotic spirit and moved by the desire that the great progress accomplished in the art of surgical anesthesia in the United States should be shared by his medical brethren in latin America, has published a Spanish edition which is offered to them as a gesture of good will and in token of a sincere and friendly effort at Inter-American medical collaboration.

Dr. Flagg's life-long interest and studies in the causes of asphyxial death and the means of preventing them, has vastly expanded his conception of the rôle of the anesthetist and his functions. While appreciating the importance of anesthesia as a special occupational field, he perceives inhalation anesthesia only as a part of a "new and major specialty," in which saving life threatened by asphyxia in its numerous and varied forms is the job for which the anesthetist is particularly fitted to fill and direct.

He believes that this triple function: *anesthesia*, putting people to sleep with gases to prevent pain, *resuscitation*, awaking people with or without the aid of gases, to keep them breathing and save them from asphyxia, and *inhallation (gas) therapy*, which treats disease by inhallation of therapeutic gases, when all combined in one personality—the trained gas specialist or *pneumatologist* (a term suggested by Carrel)—can render infinitely better service than when the allied functions are detached and exercised by separate individuals who are often chosen in emergencies.

These views have a pertinent bearing on the problems created by the war. As the author very properly suggests: "The officer receiving instructions as an anesthetist, should become acquainted with the nature and control of war gases, with the problems of high altitude flying; of submarine escape; of the effect of compressed air in diving bells, caissons, etc., with treatment of CO; poisonings; besides the knowledge of the diseases that are amenable to gas therapy." Such a man should be a qualified and accepted teacher of technical groups engaged not only in the study of anesthetics but

in the specialty of pneumatology in the broad sense in which this term has been defined.

The earnestness and enthusiasm with which Dr. Flagg has pursued his campaign of prevention against asphyxial death is seen in his inventions for the direct and more efficient application and maintenance of artificial respiration by intratracheal intubation and pulmonary ventilation or insufflation which have all contributed, since Meltzer's epochal discovery, to the present marvelous development of intrathoracic surgery. Dr. Flagg's interest and influence in rousing public attention to this vital subject is also seen in the work of the committee on asphyxia of the American Medical Association, the organization of a national society for the prevention of asphyxial death, of which he is president; and, again, by his establishment of a division of pneumatology in connection with the medical department of the World's Fair in New York, which attracted worldwide attention as an advance in the public knowledge of the dangers and prevention of asphyxial death which was far ahead of the times.

In this connection, the Preface that Dr. Flagg dedicates to the discussion of the principles and policies that apply to anesthesia in warfare will be read, we believe, with special interest by the authorities most concerned in the proper administration of this vital branch of operating service. It is evident that the methods of anesthesia must be adapted to the varying conditions met in the far-flung battle fronts of the present war, where surgery is often performed in the most varied, heroic and primitive surroundings. The methods of anesthesia must also be quite different in the outpost and casualty stations from those in the relatively safe and well organized base hospitals, where the choice of the anesthetic may be made deliberately to meet the requirements of the operation and of the patient. In the emergencies of the front, anesthesia must be obtained in the quickest and simplest way compatible with the means at hand and the condition of the patient.

It is under these circumstances that the experience and mature judgment of the author on the relative merits of the various anesthetics and anesthesia procedures best suited to meet the emergencies of surgery, as described in this book, will find their greatest value.

In regard to the choice of a routine general anesthetic, wherever such a choice is possible, the author's preference for ether, is most emphatic and unequivocal: "A personal experience with ether

(gas-oxygen ether) as an anesthetic has left the author cold to the claims of other agents suggested as basic routines." And his argument for ether "the anesthetic agent for general anesthesia in the armed forces and for civilian defense," is most eloquent and convincing.

Dr. Flagg's decided and well founded preference for ether does not mean that the claims of other rival candidates are neglected. On the contrary, chloroform, ethylene, cyclopropane, vinethene, etc., and the growing family of basal hypnotics and sedatives, no less than the methods of local, regional, spinal and caudal analgesia, are all passed in review and disposed of in brief, but lucid summaries and conclusions are given based on the mature experience and critical judgment of the author. The reader need not look here for long dissertations on controversial subjects or endless columns of bibliographic citations. This is a personal book—original in the best sense—the mirror of a man's lifelong experience—in which the stream of progress is viewed critically, lucidly and judiciously with stress on the solid things that lie in the depths without neglect of the things that float on the surface. And it is because of this fine sense of proportion and because of the high sense of responsibility and devotion to his art and to his fellows, revealed in every page of this fine book, that it will always command a distinguished and honorable place in the literature of anesthesia.

RUDOLPH MATAS.

When Dr. Novak's book[1] appeared two years ago, under the title of "Gynecology and Female Endocrinology," it was conceded that the author had written an excellent book. It had wide distribution among the profession. The fact that a second edition appears so soon is a guarantee that the material is well balanced, up-to-date and reflects the work of an experienced teacher and research worker.

We are sorry it was seen fit to drop "Female Endocrinology" from the title, because Dr. Novak has earned his right to the title of being one of the outstanding workers in this complicated and little known and appreciated field. We are sure that many readers took to the work because they believed Dr. Novak would set them

[1] Textbook of Gynecology. By Emil Novak. 2nd ed. Baltimore, 1944. The Williams & Wilkins Company. Price $8.00.

straight on many matters of female endocrinology. By and large there is, and there has been, much bilge written on this subject, and between the claims of the pharmaceutical houses and many half baked pseudo-scientific authors, the average practitioner has been in a fog and often did not know which way to turn. If the practitioner would take the time to read this book by Dr. Novak, the fog would lift and the reader would know the better how to diagnose and treat many of his patients. Although the book as a whole is of a high standard, we think it is the section that deals with female endocrinology that gives it particular value.

The book is beautifully illustrated and some illustrations are in color. It has a Bibliography or "References" at the end of the chapters and an Index. Dr. Novak's work is a well balanced, solid and readable book.

The first edition of "Clinical Urology"[2] appeared in 1940. It received favorable and enthusiastic reviews. This reviewer gave it high praise, and in the second edition he has no thought of doing otherwise than repeat this high praise and say that it is a work both the authors and publishers can look upon with satisfaction and pride. It deserves a wide sale because the authors have written good English and made the book practical and useful.

In both editions the approach of general practitioner and general surgeon to genitourinary diseases is as fully considered as the requirements of the specialist in this branch of medicine. The work is a combination of embryology, anatomy and pathology with a manual of modern operative technic. The drawings were made at the operating table by William P. Didusch. The architecture of the first edition and the above mentioned basic foundation have been preserved and revised, and new material, bringing the work up to date, has been added to this second edition.

The work is in two volumes. A workable Bibliography is at the conclusion of each chapter and there is a detailed Index.

For student, practitioner, surgeon or urologist this book is warmly recommended because it is practical, authoritative and clear and there is so much condensed in its pages.

In 1913, the late Dr. DeLee completed the first edition of what has become and has continued to be for over thirty years one of the

[2] Clinical Urology. By Oswald Swinney Lowsley and Thomas Joseph Kirwin. 2nd ed., in two volumes. Baltimore, 1944. The Williams & Wilkins Company. Price $10.00 per set.

most popular textbooks[3] of obstetrics for undergraduates and practitioners of medicine. With each succeeding edition the material was changed, brought up to date and new illustrations added. Two years before his death Dr. DeLee was asked to prepare the eighth edition. Because of his untimely death Dr. Greenhill was given the job. Dr. Greenhill's selection for this labor was a fortunate and happy one. He has done a finished piece of work.

In this edition rearrangement of material was made in the first third of the book. Another outstanding change was the substitution of English terms for the Latin ones in the designation of presentation and position. Many new chapters have been added, bringing the work abreast of the times. Much of the work has been rewritten, and old illustrations have been taken out and new ones put in their place. All in all, Greenhill has fashioned a modern, up-to-the-minute work on obstetrics built on a scientific foundation that has been standard for over three decades.

Dr. Greenhill and the publishers are to be congratulated on the end results of their efforts to keep alive and to keep in the front rank a work that has been a medical household standby for so many years.

With the passing of time gynecology also has undergone changes. To have this the more forcibly brought to mind glance through a textbook on gynecology published about 1900, or one published circa 1910 or 1920. The evolution has been gradual and slow. Today gynecology is not merely a surgical art; much of it is medical and preventive. One must know how to differentiate between functional disorders and organic; he must be familiar with the more common factors of endocrinology and chemotherapy. The thing lacking in most books on this subject in the past and, for that part, over 95 per cent of present day works, is that of female urology. At best the authors pass by this important field of medicine with scant mention. Yet every gynecologist knows that familiarity with urological conditions in the female makes him more competent to handle the more serious accidents and complications in obstetric and gynecologic practice as concerns the urinary organs. Therefore, if any one feature of Dr. Wharton's work[4] is outstanding and causes

[3] The Principles and Practice of Obstetrics. By Joseph B. DeLee and J. P. Greenhill. 8th ed. Philadelphia, 1943. W. B. Saunders. Price $10.00.

[4] Gynecology. With a Section on Female Urology. By Lawrence R. Wharton. Philadelphia, 1943. W. B. Saunders. Price $10.00.

the reviewer to recommend it, it is the part devoted to gynecologic urology.

At the beginning of each chapter is an outline so the reader may see at a glance the whole subject "in its proper proportions." The work comprises 1,006 pages, 444 illustrations, a Bibliography at the end of each chapter, and an ample Index. It is a good book from every angle.

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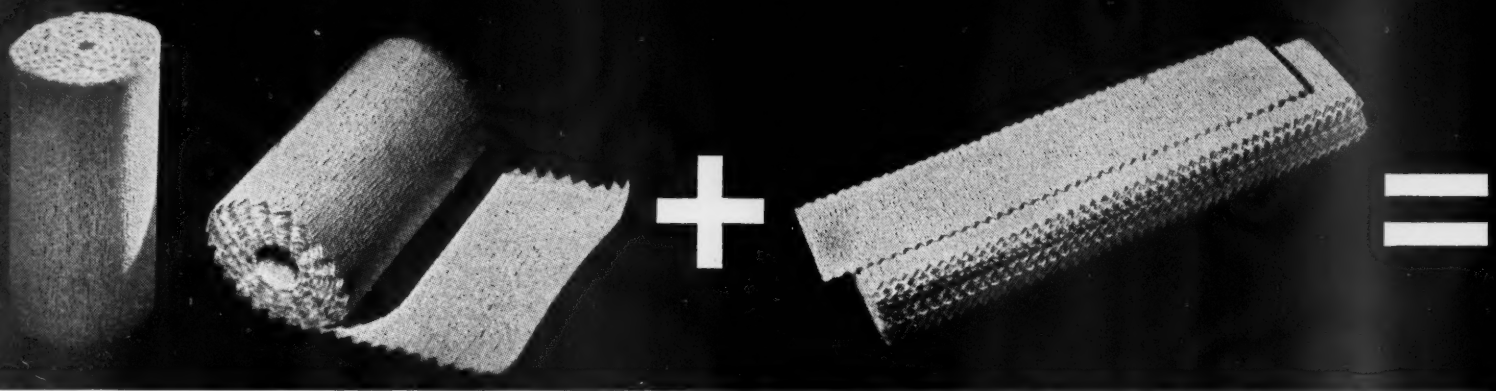

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WHETHER penicillin will be released for broad civilian practice tomorrow or on some more distant day, adequate distribution facilities for Penicillin-C.S.C. have been arranged. It will be available in every part of the United States, in amply stocked depots, to supply the needs of every physician, every hospital. For office practice and for administration in the patient's home, it will be available in combination packages providing two rubber-stoppered, serum-type vials, one containing 100,000 Oxford Units of Penicillin-C.S.C., the other permitting the withdrawal of 20 cubic centimeters of pyrogen-free physiologic salt solution in which the penicillin is to be dissolved.

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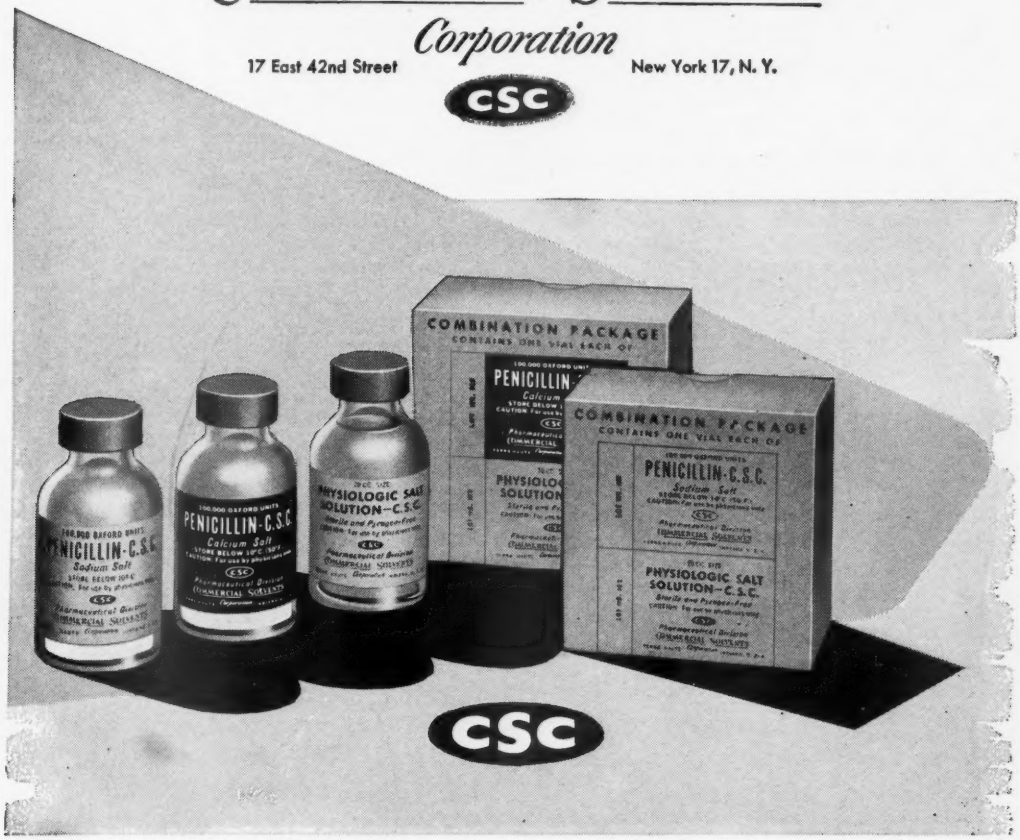

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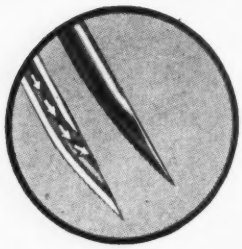


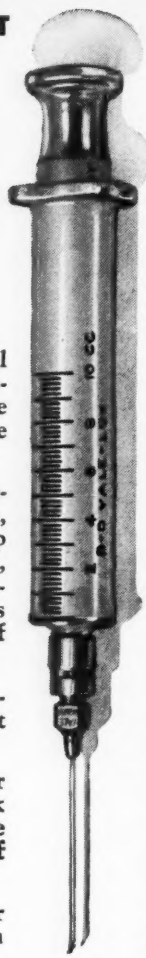
The Huber Point with closed bevel and lateral opening has such obvious advantages as to prompt the question, "Why wasn't this done long ago?"

A glance at the Huber Point design reveals why it reduces pain, trauma, and seepage. The sharp point, followed by the smooth, closed bevel, minimizes tissue disturbance and pain. It simply slits skin and tissue, the elasticity of which helps to control seepage.

B-D Yale-Lok Needles are supplied with regular or Huber Point at the same price.

B-D Yale-Lok Needles — with or without the Huber Point — lock on B-D Yale-Lok Syringes. Please be sure to specify Huber Point if you wish to receive it.

B-D Yale-Lok Needles with Huber Point are at present available from 18 gauge to 27 gauge. With regular point all standard gauges and sizes, from 13 gauge to 27 gauge, are furnished.



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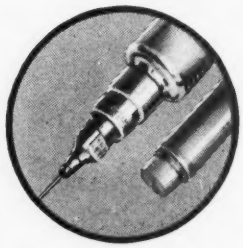
B-D YALE-LOK SYRINGES with METAL LOCKING TIP



The B-D Yale-Lok Syringe costs less to use than *any* all-glass syringe — because it eliminates tip breakage. Over 50% of the breakage of all-glass syringes occurs at the tip. Fewer replacements are needed as the Yale-Lok outlasts two or three all-glass syringes. The metal tip is *permanently* attached.

B-D Yale-Lok Needles lock on B-D Yale-Lok Syringes, with a half-turn, preventing leakage, jamming, or slipping off. A slight turn releases the needle.

B-D Yale-Lok Syringes are priced the same as B-D Yale all-glass syringes.

The larger tip outlet of the B-D Yale-Lok Syringe permits easier injection of viscous fluids. Large size Yale-Lok Syringes do not require reducing adapters. The same dimension Yale-Lok tip is used on all sizes.

B-D Yale-Lok Syringes are available in 2 cc. to 100 cc. sizes.

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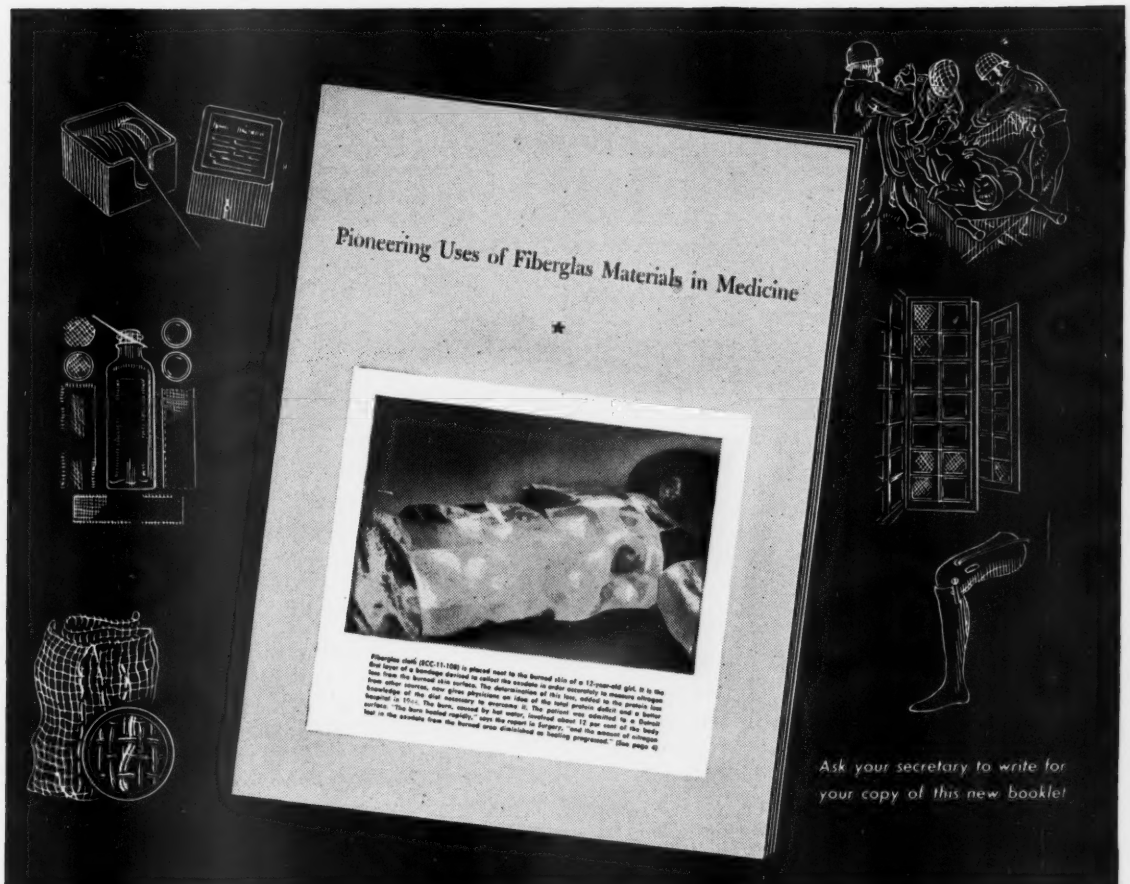

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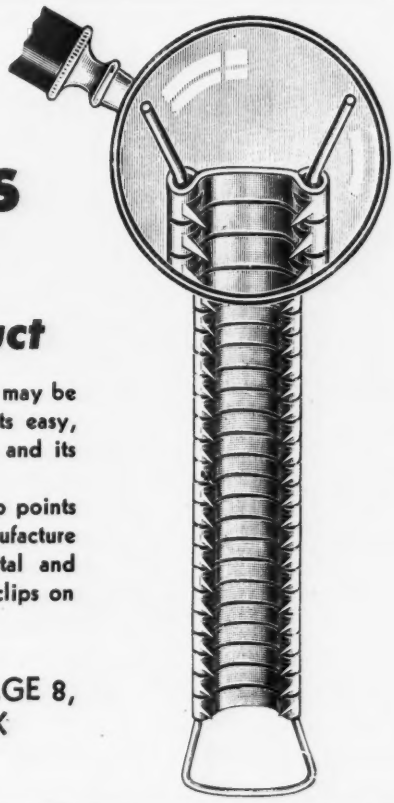

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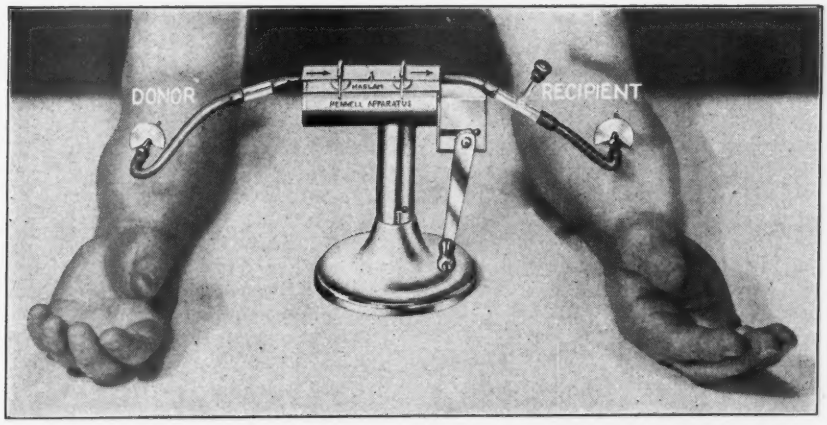

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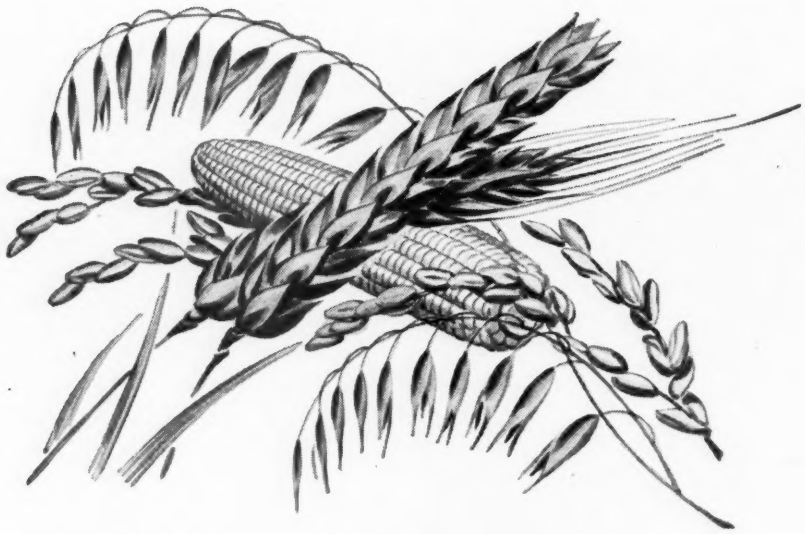

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Cereal breakfast foods fit well into the post-surgical diet designed to forestall or correct nutritional deficiencies. They are good sources of the nutrients considered important in promoting recovery.

When 1 ounce of cereal (whole-grain, enriched, or restored to whole-grain values of thiamine, niacin, and iron) is eaten with 4 ounces of whole milk and 1 teaspoon of sugar, this combination contributes appreciable amounts of biologically adequate protein, of carbohydrate and fat, as well as B vitamins and minerals. The appended table, based on composite averages for cereals and milk, shows the details of the nutritional contribution made by the combination of cereals with milk and sugar.

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Carbohydrate	**32 Gm.**
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Thiamine	**0.19 mg.**
Riboflavin	**0.27 mg.**
Niacin	**1.82 mg.**
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Iron	**1.73 mg.**

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Vitamin A	5000 U.S.P. Units
Vitamin B_1 (1 mg.)	333 U.S.P. Units
Vitamin D	500 U.S.P. Units
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together with liver concentrate (vitamin fraction), derived from 4 grams of fresh liver and dried brewers' yeast.

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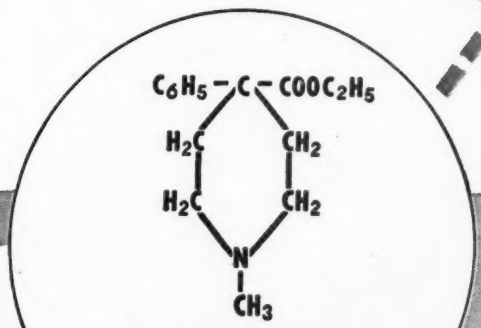

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***hexital*—A STEP FORWARD IN MENOPAUSAL THERAPY**

The American Journal of Surgery

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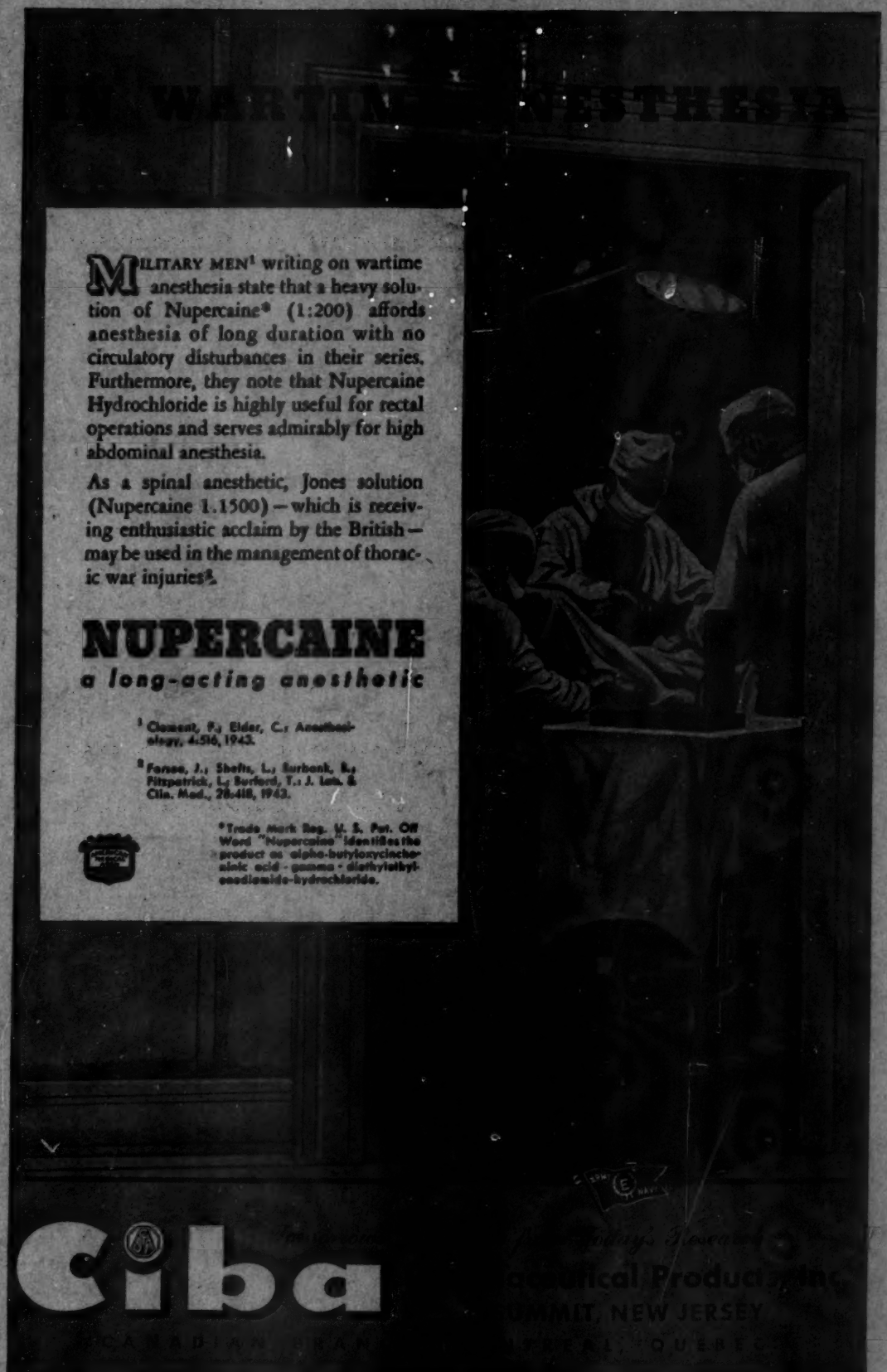

MILITARY MEN[1] writing on wartime anesthesia state that a heavy solution of Nupercaine* (1:200) affords anesthesia of long duration with no circulatory disturbances in their series. Furthermore, they note that Nupercaine Hydrochloride is highly useful for rectal operations and serves admirably for high abdominal anesthesia.

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NUPERCAINE

a long-acting anesthetic

[1] Clement, P.; Elder, C.: Anesthesiology, 4:516, 1943.

[2] Fenoe, J.; Shafa, L.; Surbank, R.; Fitzpatrick, L.; Burford, T.: J. Lab. & Clin. Med., 28:418, 1943.

*Trade Mark Reg. U. S. Pat. Off. Word "Nupercaine" identifies the product as alpha-butyloxycinchoninic acid - gamma - diethylaibyleneadiamide-hydrochloride.

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